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## Tennessee Valley Agriculture

### DEVELOPING TENNESSEE VALLEY AGRICULTURE

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When Congress created the Tennessee Valley Authority in May 1933, it charged the agency "with the broadest duty of planning for the proper use, conservation, and development of the natural resources of the Tennessee River drainage basin and its adjoining territory for the general, social, and economic welfare." The Act further provided for "proper use of marginal lands . . . agricultural and industrial development . . . promoting the prevention of soil erosion and otherwise . . . and to furnish fertilizers in the most economical manner and at the highest standard of efficiency . . . to use such products in cooperation with practical farmers . . . for the general, social, and economic welfare."

The intent of Congress was that TVA agricultural development activities be a part of a total unified development and be directed toward promotion of long-range agricultural adjustment and development. Although the language of a "systems approach" to development was not used, many concepts of systems analyses are traceable to discussions that helped establish the TVA programs in the 1930's and helped relate agricultural development activities to total resource development.

#### *Subsistence-Type Farming System*

To understand how the integrated approach to development evolved in the region, it is useful to identify the agricultural system in effect at the time of TVA's creation before discussing actual development programs. During the early 1930's, agriculture was absorbing thousands of people returning from industrial areas--unemployed, penniless, and seeking home and food. Agriculture was primarily production by a family for a family--a subsistence-type agriculture where the farm was essentially a self-contained unit. There were poverty, hunger, isolation, and a general separation of farming from the other economic forces at the time. Many problems in the Tennessee Valley agriculture were very similar to those facing many developing countries of the world today.<sup>1</sup>

There were about 349,000 farms in 1934--each depending primarily on natural forces of rainfall, sunlight, and air. Only a few specialized supplies were bought. There was limited service from public agencies, but there was a favorable public attitude toward the farmer. The farmer had a bundle of fixed resources consisting of his own labor,

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1. See figure 1 for Tennessee Valley region.

management ability founded by tradition, the land that he owned, and the capital that he had accumulated. With these he produced, processed, stored, and consumed most of his food and much of his clothing. Farm sales amounted to about \$113 million.

The processing system for agricultural products was also largely farmer owned and poorly developed. Except for a few specialized commodities like cotton and tobacco, products were intended for consumption within the region. There were few organized markets and few marketing alternatives for either farm inputs or outputs.

### *Early Strategy Developed*

Considering the subsistence nature of agriculture, TVA planners sought answers to these questions: What type of program activities could a regional agency initiate to assist farmers and help them move toward a more commercial-type operation? At what point could TVA enter and make some adjustments to influence the ongoing system? To help answer these questions, TVA management requested a conference with the research directors of the land-grant universities in the seven Tennessee Valley States. These directors advised TVA to concentrate on three problem areas: (1) improve skills in producing crops and managing farms, (2) supply farmers with plant nutrients (primarily phosphate), and (3) improve the farmer's access to inputs needed to operate a farm.

Following this conference, TVA initiated programs to help alleviate short-range ills while setting the pattern for long-range development. These programs included: (1) a direct supply of soil amendments--phosphate, lime, and later nitrogen; (2) erosion control--to improve farm income and to protect river navigation and the power system that was being developed; and (3) the promotion of farmer supply and service cooperatives. The main thrust of TVA's regional agricultural development effort dealt with crop management skills and farm management skills. These elements, when combined, would recognize the independence of farmers, would recognize their dependence on nature, and would recognize that TVA could make a contribution without becoming a direct participant in the management of farms.

### *Demonstration Method Selected*

The idea that what one sees he believes prompted program planners to select the demonstration method of teaching new skills. The strategy was to show farmers that profitable changes could be made. A 3-way partnership emerged among farmers, land-grant universities, and TVA. University staffs would provide technical assistance through research and extension; TVA would provide limited financial assistance (including fertilizers) and reimburse the university for part of its technical input; and the farmer would manage his operation, use practices recommended by TVA and the universities, and furnish information to other farmers.

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By adopting and using improved methods, the farmer would have a pilot operation where other farmers could come and see the results of a systems approach to enlightened management, skills, erosion control, and increased use of soil amendments. Both production and financial records were maintained for use in educational programs with other farmers. The concept was to obtain spread of practices from demonstration farms to other farms in the region.

Demonstrations were carried out at different levels:

1. Most were field demonstrations where one crop and either one practice or a group of practices were involved.
2. Other demonstrations included the entire farm where improved practices in all the farmers' enterprises were introduced. Records were kept, and success of the operation and demonstration was judged on the basis of total farm income.
3. Demonstrations included entire communities where all farmers participated in a demonstration of improved farm techniques.

In the early years of community demonstrations, little effort was made to contend with problems affecting the community as a whole; rather, emphasis was placed on similar problems of individual farms within the community. In later years, demonstrations were conducted to provide services for the entire community.

### *Influencing the System*

The demonstration approach was effective. However, a problem developed in the early 1960's: How could agricultural adjustments be made quickly in an era of rapidly changing economic complexities?

To give the development of the Valley's agricultural resources new vision and program sophistication, TVA and university planners created a new program activity named Rapid Adjustment Farms. This proved to be a major step in shattering the long-held concept that there were certain limits to agricultural production in the region.

Rapid adjustment is the use of pilot farms to study and demonstrate advanced levels of technology and reorganization of entire farm organizations. The strategy is to accelerate development so that a rapid adjustment farmer can attain income goals and make needed changes in 4 years compared with the normal period of 10-15 years.

Farms selected are representative of many farms in a geographic area. Resources are inventoried, management skills are evaluated, future market opportunities are forecast, and enterprise opportunities for farm production are developed by university specialists. By use of linear programming mathematical techniques, the farm is analyzed to determine the combination of enterprises and the technology that would be more profitable. Two or three plans are usually developed for different sets of constraints.



By agreement the farmer selects a farm organization plan, and professional workers at the university work with him in implementing the new technology. The farm is operated for a period of four years, financial and physical records are kept, and the farm is examined periodically for progress by professional workers.

The farming system and the record it produces are used to demonstrate to professional workers the results that will be obtained by the simultaneous use of improved organization and advanced technology. Thus, it serves as both a laboratory and a teaching tool.

The first rapid adjustment farm entered the program in 1962. By 1967 this farm had completed its cycle of adjustment and program participation. The following year (1968) the first statistical report of a group of rapid adjustment farms was published. The technique has now become operational. It is now considered to be the major part of the cooperative TVA-university programs with the region's farmers and is considered one of the most effective methods to systematically introduce change into the farming system.

These farms have identified a fantastic potential for increased agricultural income. The typical farmer, for example, makes about \$4,000 in annual net income when he goes on the program (table 1). By the fourth year of the program, he typically makes about \$8,700--an increase of 124 percent. Included with income growth is an increase in investment of about 61 percent. Structurally, crop sales usually remain about the same, while livestock sales increase about 200 percent. This reflects and demonstrates the general type of changes that need to be made in the region for full agricultural development to occur.

Table 1

Financial Progress on Graduate Rapid Adjustment Farms

	<u>Benchmark</u>	<u>Fourth Year</u>	<u>% Change</u>
Gross farm income	\$14,286	\$32,038	124.3
Net farm income	3,885	8,718	124.4
Investment	41,439	66,711	61.0

*1934-1964 Changes*

Development programs conducted by TVA and other regional institutions, major advances in technology, along with changing social, political, and economic conditions, created major agricultural changes during the 1934-1964 period. To accelerate continued development of the region's agriculture, TVA and university planners evaluated these changes in the late 1960's.

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The TVA-university programs aimed at increasing farm production technology and management had been effective. For example, corn production per acre had increased from 19 to 46 bushels (over 200 percent increase). Cotton yields had about doubled what they were in 1934 (see table 2). Total farm product sales moved up, too--from \$113 million in 1934 to \$661 million in 1964--a change of almost 500 percent. Deflated for changes in prices, the product more than doubled.

Other changes were taking place. The mix in farm production was reversing. While crop production increased to only 411 percent, livestock production increased to almost 800 percent over what it was in 1934.

These farm production changes also permitted structural changes to occur in the total economic system. While the total population of the region continued to increase, the number of farms, farm labor input, and farm population decreased. Farm numbers were down to less than one-half what they were 30 years before; farm population was about a third. Younger farmers with children showed the greatest decline.

With a decline in entry rate of farmers, the farm population was advanced in age so that the real decline in labor force on the farm was even greater than the numbers would indicate. Amount of land used for farming was also declining. Openland in farms had dropped from 13 million to 10 million acres.

This decline in resources used on farms represented another contribution that agriculture was making to the total economy. That is, with more efficient farm operations, fewer farmers could produce a larger output. They could then release labor resources formerly required to provide food for jobs in nonfarm production. Nonfarm industrial growth was abetted by increased efficiency in agriculture, which permitted the release of resources--capital, labor, and land--for use in industrial development. This transference of resources illustrates the integrated approach of TVA to solving many of the region's problems.

By 1964, a number of other general changes were apparent. Farming was no longer a subsistence activity where the farmer was producing for his own consumption. Rather, most farmers had now entered commercial production where they sold products and purchased consumer items. Farmers were producing, not only for national consumption, but were in world markets. By 1964, one dollar out of seven of regional farm income came from foreign sales of farm products. This amount continues to grow.

Farmers were no longer isolated in an agrarian social system. They were now technology oriented. Farmers were actively seeking new skills to use. They recognized a dependence on outside information in decision-making. Included was a dependence on resource and commodity markets. Many had begun to recognize that social decisions of local, state, and national governments were affecting farmers' welfare, income, and ability to operate in a profit-seeking manner.

Table 2

Changes in Tennessee Valley Agriculture,  
1934-1964

	<u>1934</u>	<u>1964</u>		<u>1964 as a</u> <u>Percent of 1934</u>	
		<u>At 1964</u> <u>Prices</u>	<u>At 1934</u> <u>Prices</u>	<u>At 1964</u> <u>Prices</u>	<u>At 1934</u> <u>Prices</u>
Corn, bushels/acre	19.50	46.40	-	238	-
Cotton, bales/acre	.52	1.18	-	227	-
Tobacco, pounds/acre	852.00	1,914.00	-	225	-
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Farm product sales (\$1,000,000)	113	661	250	585	212
Crop product sales (\$1,000,000)	62	255	97	411	156
Livestock product sales (\$1,000,000)	51	404	154	792	302
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Farm product sales, \$/hour	.12	1.84	.70	1,533	583
<hr/>					
Openland in farms (million acres)	13.80	10.20	x	74	x
Harvested cropland (million acres)	7.4	3.4	x	46	x
<hr/>					
Farm numbers (1,000)	349	164	x	47	x
Farm population (1,000,000)	1.80	.55	x	31	x

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### *New Problems and Opportunities*

Although early programs helped farmers make changes during this 30-year period, these adjustments created other problems for regional planners. As farmers became more commercial and depended more on outside markets, they needed a new set of skills involving market and public policy knowledge. As they became dependent on the buyer of their products, what happened in the buyer's business also affected their welfare. As they depended on foreign markets, they needed skills to anticipate and adjust to changes in the foreign market. As they released some resources to industry, industry expanded and became a competitor for other resources.

Some public officials looked at the decline in the number of farmers and concluded that farming was no longer important to the economy. Thus, in the period 1966 and 1967, TVA made a systematic reevaluation of its regional efforts to promote the agricultural industry and developed new program objectives.

While the concept of TVA originally included an integrated, comprehensive view of the total social and economic problems of man, the techniques for approaching problems in this manner were not developed in the beginning. This concept evolved over time. TVA initiated the 1966 evaluation of agricultural development problems in a way that approached what is now considered systems analysis. During this evaluation, the concept that the farmer had a given bundle of resources to manage remained a cornerstone of the new program ideas. However, new elements of reasoning came into the process. Recognition was given to the importance of input suppliers, the farmer was considered only one stage in the total transformation process, specific development barriers were identified as problems to be overcome, food processors and marketing firms were recognized as an integral part of agriculture, and, finally, the consumer was accepted as the ultimate purpose and destination of all production. Another major difference was the concept that agriculture was no longer an isolated, independent function--rather it was an integral part of the total economic and social structure of the region. The evaluation showed that agriculture was still a major dynamic regional industry.

### *New Potential Recognized*

These new situations and new program possibilities were used in a study of agricultural potentials for the region. As a first step in the study, certain assumptions were made, and production potentials were computed. This analysis served three major functions: (1) Major areas offering opportunity for improving Valley agriculture were identified, and the relative importance of each was ascertained; (2) a basis for determining program objectives was provided; and (3) guidelines for developing and selecting new program elements were identified.

The assumptions used in arriving at the estimates of potentials reflected sustained economic growth equal to the past 20 years, unlimited capital, stable prices, favorable markets, full mobility of

resources constant Government restrictions on production at 1967 level, and a goal of maximum farm income.

More specific assumptions were: (1) Row crops would be produced on all classes I and II openland and one-half of class III openland, (2) pastures would utilize the remaining openland in class III and all of classes IV through VI, (3) all land in classes VII and VIII would be used for forest, and (4) land now in forest would remain in that use. The levels of crop yields used in estimating potentials were based on normal growing seasons and application of presently known technology.

Livestock production potentials (not including poultry) were limited to available feed supply and labor. Imported feed was assumed to be available at prices favorable to expansion of poultry production.

The Valley was divided into nine physiographic regions having similar land characteristics because of the wide diversity of problems and resources (figure 1). Budgeting procedures used for individual farm planning were modified to estimate potential production that could exist if assumptions stated earlier were met.

Harvested crop acreage could be 75 percent greater than in 1964. Both acreage and yield increases could occur in corn, soybeans, small grains, hay, and vegetables. Most dramatic acreage increases would occur in corn (from 884,000 acres in 1964 to a potential 2,000,000 acres), soybeans (from 140,000 to 500,000 acres), and hay (from 1.3 million to 2.0 million acres). Acreage used for all harvested crops would increase from 3.25 million to more than 5.75 million acres.

Attaining potentials would increase the value of crop production two and one-half times--from \$293 million in 1964 to \$759 million. Production per acre of harvested land would be valued at \$131 compared with \$93 in 1964.

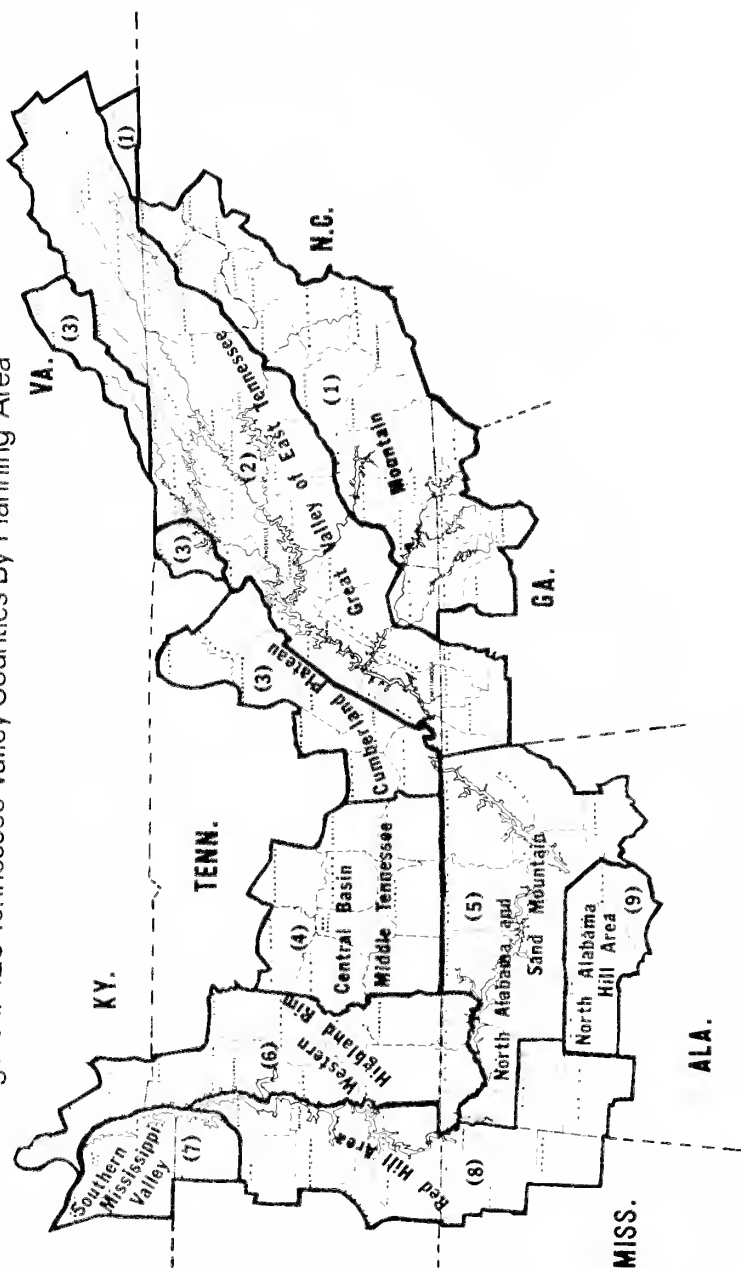
Livestock production potentials were even greater. Based on the feed supply assumed available if crop potential were attained, there would be a potential for nearly 3 million cattle and calves, 7 million hogs, and 46 million hundredweight of grade A milk. Potential poultry numbers were estimated at 511 million broilers and 22 million layers.

The potential value of livestock and poultry production would be nearly three times the 1964 level. The total value of the livestock and poultry potential would amount to \$1.3 billion as compared with \$454 million in 1964. Most classes of livestock could double in numbers, but a large share of the expansion would be in beef cattle and poultry. The large expansion in milk production would result mainly from increased production per cow rather than an increase in numbers.

If both crop and livestock potentials were attained, the total value of Valley agriculture would be \$1.0 billion greater than the 1964 level. The total agricultural potential for the Valley approached \$1.7 billion compared with \$634 million in 1964 at constant 1964 prices.



Figure 1. 125 Tennessee Valley Counties By Planning Area



This indicates that agriculture was operating at only about one-third its physical capacity (table 3). Recognizing this relative position was actually more important than the absolute dollar figures and provided a rallying point for implementing and promoting new program activities.

The additional agricultural production would have a pronounced effect on the volume of Valley agribusiness and the total economy. Recent studies had shown that for every 38 cents of farm products produced, an additional 62 cents was spent for marketing and processing services.<sup>1</sup> Using this same relationship, the added \$1.0 billion agricultural production would generate an additional \$1.6 billion for marketing and processing. This expanded volume of business would also require expanded employment to process and distribute and food.

Table 3

Summary of Agricultural Production Potentials,  
Tennessee Valley

	<u>1964</u>	<u>Potential</u>	<u>Increase</u>	
	<u>Million</u>	<u>Million</u>	<u>Million</u>	<u>Percent</u>
	<u>Dollars</u>	<u>Dollars</u>	<u>Dollars</u>	
Total crops	293	759	466	159
Less feed crops used	<u>113</u>	<u>425</u>	<u>312</u>	<u>276</u>
Other crops	180	334	154	86
Livestock	<u>454</u>	<u>1,339</u>	<u>885</u>	<u>195</u>
Total	634	1,673	1,039	164

Farm suppliers would play an even more important role in agricultural development activities. The farm input market would expand because of increases in the use of fertilizers, chemicals, feeds, machinery and equipment, operating capital, and hired management.

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1. For examples, see:

- (1) Abbas Mirakhor and Frank Orazem, "Importance of the Farm Sector to the Economy: A Multiplier Approach," in *American Journal of Agricultural Economics*, Nov. 1968, p. 913.
- (2) USDA, "The Asheville Analysis" in *The Farm Index*, June 1968, p. 7.
- (3) Carl E. Madewell, Maurice J. Danner, and A. R. Cavender, "Agribusiness Growth in the Tennessee Valley Counties of Alabama," Bulletin Y-72, NFDX, Tennessee Valley Authority. April 1974.

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Consequently, agribusiness firms would have to be much larger, offering more services and advice. Lending agencies would be called upon to make adjustments in their lending policies so they could provide the additional capital required.

### *Barriers to be Overcome*

But why did not the farmers reach this potential if they, in fact, existed? This was examined in the 1966 program study. There were specific groups of problems identified--called barriers--which were preventing farmers from reaching their potential. These were identified as follows:

*Management and technological restraints*--Failure of farmers to adopt available technical know-how and to fit it into good management systems was restricting resource utilization and increased incomes. Output per unit of input was lower in the Valley than in the rest of the Southeast and the Nation.

*Size of farm and tenure restrictions*--In 1964, two-thirds of Valley farms contained less than 100 acres, and 40 percent contained less than 50 acres. Less than 60 percent of farm acreage is openland suitable for crops. As a result, most Valley farms are too small to support economic farming units for many types of agriculture. The farm size problem was further complicated by prevailing land ownership and tenure patterns that discourage efficient land use.

*Land capability restrictions*--Present land use in the Valley was less than optimum. More than 5 million acres of classes I to IV land in forest should be in agriculture. Approximately 2.3 million acres of classes VI to VIII land being cultivated should be used for growing trees. Considerable portions of good Valley soils are located in small, fragmented patches adjacent to soils of lower productivity which hinder their use for farming.

*Human and cultural restraints*--Over one-fifth of Valley farmers were 65 years old or over, and over three-fifths of the farmers had eight years or less of schooling. Thus, a majority of the present farmers were elderly, poorly educated, and lacking in labor skills or financial resources necessary to make the adjustment to significantly alter their economic condition.

*Institutional restrictions*--Acreage restrictions, acreage diversions, market regulations, and land tax policies were restricting resource use and the development of commercial agriculture.

*Market limitations*--Growth of agricultural markets had been phenomenal in recent years, but marketing costs were rising sharply, and many problems were evolving for Valley farmers. A general lack of understanding of marketing prevailed.

*Relative Importance of Barriers Studied*

The barriers limiting attainment of the full agricultural potential were rated in terms of their relative importance. Several independent studies--mostly unpublished--had established a basis for many of the individual estimates. Nevertheless, they are combined personal judgments of the authors and other TVA agricultural development staff.

The management and technology barrier was assessed to be most important if it was assumed to be independent of the other five impediments. However, management problems are so closely related to the other categories that usually it is difficult to consider one without the other. For example, tenure and land use problems can be considered separately from management for purposes here, but, ultimately, they must be considered together when developing programs. In fact, all barriers are so interrelated that they cannot be dealt with apart from the human factor. Nevertheless, analysis was made to assign ranks (given below) to barriers in terms of the degree to which each impeded the attainment of the overall potential increase of \$1 billion in value of farm production. The market limitations do not include the value of restrictions on agribusiness which would be part of industrial and total economic development objectives.

1. Management and technological restraints	\$ 375,000,000
2. Size of farm and tenure restrictions	175,000,000
3. Land capability restrictions	175,000,000
4. Human and cultural restraints	175,000,000
5. Institutional restrictions	50,000,000
6. Market limitations	<u>50,000,000</u>

Total potential not reached	\$1,000,000,000
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Following this program review, it was universally recognized that interests, needs, and opportunities of farmers had expanded from technology adoption and management of resources to a wide range of problems. Therefore, TVA initiated an expanded agricultural development program to include some effort to remove each of these six barriers.

*Objectives of New Program Designed*

The overall objective of Valley agricultural resource development programs is to maximize income to the agricultural sector, subject to relevant constraints. The objective of TVA is to maximize "... general, social, and economic welfare"; hence, the objective for agricultural development becomes one of suboptimization because agriculture is only one component of the Valley's economy. Therefore, agriculture must be considered within a "systems" approach if maximum efficiency is to be obtained for the Valley's total economy.

The areas identified as barriers to Valley agricultural development logically identified program subobjectives. Subobjectives aimed at overcoming or minimizing the effects of each of the barriers are to:

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- a. Improve management on farms and encourage adoption of improved technology.
- b. Promote farm consolidation and improved tenure arrangements.
- c. Encourage changes in land use compatible with its highest economic capability.
- d. Improve the educational levels of rural people in the Valley and help them to adjust to social and economic change.
- e. Investigate and assess institutional restrictions hindering Valley agricultural development and to bring them to the attention of Federal, state, and local governments.
- f. Promote market education and upgrade and expand marketing systems.

Specific goals for each objective were not set nor were time-phased goals set at that time. However, an overall goal for agricultural production was set at \$1.67 billion on the basis of the estimated long-range potential. It was hoped that as progress was made toward this goal, research would develop new technology so that a higher potential might later be set.

### *New Program Activities Identified*

Efforts to introduce technology and improve management ability of farmers remained the primary activity. Two new TVA program activities (agribusiness and institutional development) received most of the attention after the review.

The expanded interest into these new areas required somewhat different approaches to the traditional activities of agricultural development. It called for dealing with a much wider audience and clientele.

The major changes included expansion of the dissemination of information, largely through the formation of activities such as rural life conferences and providing planning assistance to other organizations. In rural life conferences, TVA serves as a catalyst in calling together people who have information on a problem of current interest in agricultural development, stimulating an exchange of knowledge, preparing a result of the discussions into a proceedings, and making the proceedings available to anyone who is interested in agricultural development. The basic principle of working with and through existing organizations is maintained through joint sponsors of the workshops or conferences. Seldom is a conference held with only TVA as a sponsor.



*Agribusiness Development Promoted*

The farmer now depends on others to process and market his products. How these agribusiness firms conducted themselves had a major influence on the development of agriculture both through actual handling of the products and through the information they disseminated to farmers. Therefore, work with agribusiness firms became a major activity following the 1966 review.

Activities to promote agribusiness included feasibility studies of needed farm supply firms, training schools for certain types of agribusiness firms such as lime vendors, and conferences to point out opportunities for agribusiness leaders to expand their businesses. Also, development groups such as planning commissions and chambers of commerce are informed of the impact of farm production on total industrial growth.

*Institutional Development Required*

Another area of expanded concern is in public decisions affecting land use. The expanding industrial and urban development, including transportation, was taking much land from agriculture in an unplanned, unorganized, unsystematic way--usually the lands most suitable for agriculture. With the passing of agricultural surpluses, the general worldwide food shortages, and the expanded opportunities to market food abroad, the protection of needed land is becoming a major concern. By providing agricultural information to development planning bodies, these problems and opportunities can be articulated, and more informed decisions can be made concerning the use of land and other resources.

Working with emerging planning and development bodies helps these institutions to grow and take their places as effective organizations.

*Environment Must Be Considered*

Another public issue that emerged shortly after the 1966 program review was the concern for environmental protection. Since the industrial revolution, the United States' population had been obsessed with expanding the production of material goods, including food and fiber. Natural resources were considered awaiting for exploitation and used to produce desired material goods. It was recognized in the 1960's that in the process of producing for an expanding population many byproducts had tended to destroy the original environment. Thus, in the early 1960's, a number of activities were initiated to protect the environment, sometimes at the cost of efficient production.

Changes in national policy as well as local interest required TVA to assess more completely the impacts of its own construction and other construction that is promoted in terms of lost agricultural production and other changes in the environment. Many of the technologies that had been introduced in the past 30 years included processes that depended on manufactured purchased inputs--petroleum, chemicals, and

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other inputs for which the byproduct was not fully understood and was now associated with fears of degrading the environment. Because of this, much of the effort of the agricultural development program in recent years has been to assess the environmental impact of the use of agricultural technology as well as the impact of nonfarm changes upon agriculture itself.

### *Development Has Occurred*

Cash receipts from farm marketings reached an all-time high in the region in 1976. Farm product sales in the Valley were an estimated \$1.7 billion, while sales for the rest of the U.S. reached \$94.8 billion. The significant question, though, is how have Tennessee Valley farmers fared compared with other American farmers (table 4).

Table 4

#### Selected Information for the Tennessee Valley Region and United States--1934-1976

	<u>125 Valley Counties</u>	<u>U.S.</u>	<u>Valley as Percent of U.S.</u>
1934 farm product sales	\$113.0 million	\$6,357 million	1.78
1976 farm product sales (in 1934 dollars)	\$ 1.7 billion (est.) (\$330 million)	\$ 94.8 billion (\$18.3 billion)	1.79
1934 \$ sales per harvested acre	\$ 15.27	\$ 21.50	71.0
1976 \$ sales per harvested acre (in 1934 dollars)	\$487 (est.) (\$94)	\$287 (\$55)	170
1934 average size farm, acres	70	155	45
1976 average size farm, acres	119 (est.)	389	31

In 1934 when Valley sales totaled \$113 million, this volume represented 1.78 percent of total U.S. agricultural sales. By 1976 when Valley sales increased to an estimated \$1.7 billion, this volume represented 1.79 percent of total U.S. agricultural sales. For both the U.S. and the region, this represented an increase in farm sales of 15 times from 1934 to 1973. In essence, there was no significant difference in the aggregate growth pattern of the valley from the U.S.

In 1934 the average size of farm in the Valley was 70 acres compared with 155 acres for the U.S. In 1976 Valley farms had increased to 119 acres, while for the U.S. the average size was 389 acres. Relatively, Valley farms are becoming smaller when compared with the U.S. Thus, as described previously, Valley farmers have had to make more intensive use of their limited land resources.

Valley farmers have intensified production per acre of land dramatically. In 1934 sales per harvested acre in the region was \$15.27 and for the U.S., \$21.50. By 1976 sales per harvested acre in the region had increased to \$487, while for the U.S. sales were \$287 per harvested acre. These changes are consistent with the objectives of TVA's agricultural program. Even since the 1967 program reorientation, farm sales have increased by one-third in constant (1964) dollar value. This achieved one-third of the potential as recognized in 1967.

#### *Other Problems to Solve*

Although the system is working, there are still many problems retarding the region's agricultural development. A few of the more important are:

*Rural Involvement in Public Land Use Decisions*--While the farmer was originally an independent operator dealing mainly with nature, he has recently found himself in an environment where public decisions are equally important to his welfare. He has come to want many of the public services considered to be urban in the past. He wants good roads, schools, and medical facilities, for example. It has been difficult for the farmer to become a part of the decisionmaking bodies that provide desired services. He has traditionally been independent and isolated, making him ill-equipped and reluctant to participate in public decisions. How to give farmers the skills to participate in public decisions remains an evasive issue for both the affected farmer and the professionals who would lead him.

*Emergence of New Publics to Influence Agriculture*--Another problem is the emergence of new publics to support, oppose, and control agriculture. In the early days, the farmers were large enough in number that they could elect their own representatives in the public decision-making bodies at the national level. In recent years, the consumers of farm products have taken as active a role as the producers in promoting farm policy at the national, state, and local levels. Thus, many acts have been taken to influence inputs and control the production and marketing of farm products that the farmer does not understand. These acts do not always work to his advantage.

*Disappearance of Food Surplus and Reemergence of Food Scarcity*--World hunger is again influencing the production of food. During the past 30 years, introduction of new technology had--at least in this country--removed the fear of hunger. Rather, fears were caused by over-production of food and the U.S. entered the world market. U.S. reserves have now disappeared. High prices and actual shortages of

## Tennessee Valley Agriculture

some food have appeared as sales have moved U.S. commodities into the world market.

Consumers who had been accustomed to low prices based on food surpluses attempted to enforce policies that inadvertently oppose the efficient production of food. An appraisal of the long-term demands for food and the long-term ability of agriculture to meet those demands remains an important problem in the world.

*Choice Between Food and Other Desired Goals*--A better understanding is needed of the trade-off values among food production, environmental protection, fuel conservation, and other goals in our regional development policy. As the price of fuels becomes higher and scarcer, as environmentalists tend to pose restrictive use of efficiency-promoting inputs and technology, and as other public issues that affect the efficiency of food production emerge, many more problems are likely to face the farmer.

There will ever be a need for clearer understanding of the actual physical and biological processes, the economic return, and the trade-offs between desirable goals. Generally, decisions are left to be made either by the private sector in the market place or by the voter and his elected representative as public policy is developed.

*Meeting Energy Crises*--Much of the progress was built on increased use of petroleum for fuel on the farm and in inputs such as fertilizer. Increased cost and reduced availability of petroleum will have tremendous effects on the profitability of farming. Increased production will need to be found in lower fuel-using practices.

*Limited Resource Farms*--A final unresolved issue is what to do about the farmer who has been bypassed by modern technology and by other adjustments that have improved the nutrition and income of masses. The older and less educated farmer and the farmer with limited size of farm and other resources have been left with low incomes.

In recent years, increasing amounts of TVA agricultural development resources have been shifted to trying to understand the limited resource farmer and to develop ways in which he can be helped to adjust to the competition of his more prosperous neighbor.

### *Summary*

TVA's agricultural program is one of a number of subsystems which constitute the total system of regional resource development. The TVA Act provided for a long-range program of agricultural readjustment and development, watershed protection, and fertilizer development and use as an integral part of a comprehensive regional program. This program provided for enlistment of the people and their organizations and for cooperation with local, state, and Federal agencies in reaching for the common goal of sound physical, economic, and social development of the Valley. Thus, TVA's efforts were to complement--not replace--the independent economic system.

In 1933, the farming system was generally a subsistence agriculture forming an almost independent and separate part of the economy. The program system used to develop it was a simple one, consisting mainly of a 3-way partnership with the land-grant university, TVA, and selected demonstration farmers. The main thrust dealt with demonstrating to all farmers the effects of improved crop and farm management skills.

By the 1960's the approach had proven effective. But economic conditions had become more complex and were changing more rapidly. A more skillful tool of demonstration and education was developed.

The use of linear programming in farm operation, along with the most advanced technology known by researchers was combined into a new element--the Rapid Adjustment Farm. The audience for its results is professional farm leaders and the time of study is 10 to 15 years ahead rather than present. Thus, the main thrust was changed to influence farmers indirectly through professional leaders.

These farmers have identified fantastic potentials--typically tripling production and doubling net income in four years.

Success of the earlier programs, along with changes in the economy, created new problems for the farm sector. An intensive evaluation of these changes and implications of these was carried out in 1966. The new program added several objectives such as changing the amount of resources the farmer has, land and tenure problems, institutional, environmental, and other restraints.

During the period, the farming system has responded to the program system. By 1976, for example, total food produced had increased from \$113 million to \$1.7 billion. This is 15 times the original output in current dollars or 3 times the value in constant dollars. And, it has done so with fewer resources--about 60 percent the land and 35 percent of the farm operators.

Working on these problems has created knowledge of the increasing complexity of the farming system and the expanding areas of need for program systems to assist it. New problems recognized for which little guidance is available include:

1. Rural involvement in public land-use decisions affecting them.
2. Emergence of new publics to influence agriculture.
3. Disappearance of food surplus and reemergence of food scarcity.
4. Choice between food and other goals of society.
5. Lower energy systems.
6. Plight of the limited-resource farmer who has been bypassed by progress.



THE MIASMIST AS REFORMER:  
JOHN H. GRISCOM AS A TEST CASE

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Central to nineteenth century humanitarian reform movements was urban health reform. Those portions of the city allotted to the working classes desperately needed improvement. Streets and tenements piled high with garbage were filthy and unsafe. As well as shortening the inhabitants life expectancies, the slum districts bred crime, disease, immorality, and intemperance. Many humanitarians believed that people struggling for life in some dark hovel could not be interested in reform movements such as the abolition of capital punishment or women's rights. Reformers therefore urged society to improve living conditions for the masses and then strive to improve the rights of prisoners or women. The basic problems were the back courts, the flooded cellars, or the windowless apartments on the top floor of a tenement firetrap. Inadequate housing resulted in intemperance and in crimes that might ultimately lead to capital punishment. Excessive rents forced the husband to send out his wife and children in search of work. Reformers saw a vicious circle, and they stoutly maintained that elimination of the root evil--dehumanizing living conditions--would make the other problems easier to treat.<sup>1</sup>

Public health became a matter of extreme urgency in nineteenth-century American cities because of the industrial revolution. Industrialization and technological advances necessitated a concentrated labor force, which resulted in the enlargement of factory towns. Decreasing standards of living and incredible overcrowding resulted from the flow of workers to the city. An almost complete lack of urban planning and regulation, combined with greed, led to the building of houses and factories without regard for health or sanitation. Poor transportation forced workers to live close to their places of employment, which meant extreme congestion.<sup>2</sup>

The late 1830's depression in the United States caused renewed interest in social reform. People from all social classes and walks of life became involved. Reformers, especially those active in public health, were products of the Enlightenment, and as such were strongly imbued with the idea of protecting natural rights, and none more so than the right to life. In a report on the 1849 cholera epidemic in Boston, the city's leading physician-reformers contended that the state had a duty to protect an individual's health just as it protected his property. Combined with Enlightenment thought were the achievements in science and technology which revived the ideas of progress, and romanticism, whose advocates believed that man was improvable, thereby further strengthening the concept of progress. Most reformers were, to one degree or another, perfectionists who held that human freedom meant more than simply political liberty. Popular government was supposed to protect individual liberty and the "rights of the unfortunate."

As a result, "in the name of democracy the special privileges of business were attacked and the rights of the working class vigorously asserted."<sup>3</sup>

The period from 1840 to the Civil War was one of change and anxiety in America. Not everyone viewed industrialization as an unmixed blessing. In fact, feelings of anxiety and fear concerning the effects of industrialization helped bring about humanitarian reform. During the 1840's many Americans "argued that there was no valid excuse, moral or economic, for the presence of want in the midst of plenty; they condemned the bending of human lives to the will of the machines as inhumane and unwise; and they expressed regret and concern at the signs of growing estrangement between social classes."<sup>4</sup>

In pre-Civil War America, those physicians who accepted the miasma theory of disease causation contended that filth removal would ease the burden of disease, thereby improving the living conditions of the lower classes. One of the most active of these physician-reformers was Dr. John H. Griscom (1809-1874), a New York City physician educated at the prestigious University of Pennsylvania Medical School. Griscom devoted the major portion of his life to alleviating the suffering of "how the other half lives." Believing that overflowing privies, putrefying garbage, filthy streets, rancid slaughterhouses, and other nuisances common to nineteenth century cities spread cholera, typhus, typhoid, consumption and a host of other diseases, Griscom labored to end these abuses. His endeavors in prison reform, immigration reform and tenement house reform, to mention a few, were related to his acceptance of the miasma theory. He served as City Inspector (chief health officer for New York), General Agent of the New York Commissioners of Emigration, and Chairman of the Board of the New York Prison Association, devoting his time and energy to the avoidance of obvious nuisances. He influenced the passage of an improved immigrant shipping law and the Metropolitan Health Bill--both pioneering pieces of legislation--as well as sponsoring tenement house controls, new prison reforms and the creation of new parks for the crowded lower wards of Manhattan.

Dr. Griscom always based his proposed reforms on his understanding of medicine and medical science. Until the bacteriological discoveries of the late nineteenth century, regular physicians (excluding quacks and sectarian practitioners) were either miasmists, the dominant group during Griscom's lifetime, contagionists or limited contagionists. The English physician Thomas Sydenham (1624-1689) formalized the miasma or atmospheric theory of disease causation. Sydenham assumed that malefic changes in the atmosphere, perhaps due to the noxious effluvia "arising from the earth," caused the waxing and waning of epidemic disorders such as plague, dysentery, or smallpox. Adherents to the miasma theory believed that the overflowing privies, filthy streets, and deleterious manufactories created a local atmospheric state which in turn produced disease. The contagion theory, on the other hand, held that disease resulted from specific organisms or fomites. A leading contagionist was Dr. John Snow, the English physician who discovered that cholera was water-borne. Limited contagionists stood between these two schools, contending that while filth caused some diseases, others resulted from

specific organisms. This lack of precision can be illustrated in Dunglison's medical dictionary, an accepted nineteenth-century authority. When defining contagion, he pointed out that "physicians are, indeed, by no means unanimous in deciding what diseases are contagious, and what not." Contagious diseases were produced by a virus or "by miasmata, proceeding from a sick individual. . . ." To confuse issues further, some diseases were contagious in some circumstances but not in others. The opposite of epidemic or contagious diseases were endemic afflictions which arose "from some peculiarity in a situation or locality." Unfortunately, as Dunglison pointed out, physicians had "no accurate knowledge of the emanations or other circumstances which give occasion to endemic afflictions." Obviously this lack of unity and understanding undermined the authority of the physician-reformer. Whereas Griscom and the miasmists called repeatedly for clean streets and a healthier environment for the poor, contagionists argued that such improvements would have had little or no effect on mortality rates. And as long as the debate continued, during normal times city fathers saw little reason to concern themselves with the city's cleanliness.<sup>5</sup>

Griscom contended that while the pernicious emanations of swamps were bad for the health of the masses, the effluvium from the mountains of filth that daily grew larger in the streets was infinitely more harmful:

At all seasons of the year, there is an amount of sickness and death in this, as in all large cities, far beyond those of less densely peopled places . . . proving conclusively that the congregation of animal and vegetable matters, with their constant effluvia, which has less chance to escape from the premises, in proportion to the absence of free circulation of air, is detrimental to the health of the inhabitants.

Smallpox, cholera, typhus, diarrhoea, dysentery, and malaria were among the diseases that supposedly arose from the miasma of putrefying garbage in the street, from the filth that collected in the hallways, from the human excrement that oozed from privies located in already filthy courtyards, and from the rank air of poorly ventilated apartments. (Yellow fever, Griscom thought, could not arise in New York unless the "seeds" first were introduced from the South.) The combined evils of dampness and vitiated air caused, so the miasmists thought, consumption, the most common affliction of the tenement dweller. The miasmist theory, which lacked precise definition because of limited knowledge, included the "shears of fate," a concept applied to many of the zymotic (epidemic) diseases. One shear represented atmospheric conditions, which when combined with the other shear of filth in the streets, created the proper environment for all manner of diseases. Griscom accepted the shears analogy in some cases (cholera) and rejected it in others (yellow fever).<sup>6</sup>

Until the 1870's the miasma theory was quite popular with physicians and with reformers, on both sides of the Atlantic. Miasmists supported the elimination of decaying organic matter, which in their minds produced disease-ridden effluvia. The miasma theory provided an opportunity

to strike out against the inhuman living conditions of the poor. The contagionists, on the other hand, supported quarantines aimed at preventing the introduction of disease. The interest in liberal reform forced the contagionists to support a theory which represented despotism over individual liberty and officialdom rather than the private citizen. Even after the discoveries of Lister, Pasteur and Koch, the battle raged on, but it became increasingly clear that the miasmists were in error. From a scientific point of view, however, the putrefying garbage provided a breeding ground for microorganisms and insect vectors, and from a humanitarian view, the incessant filth dehumanized the poor and destroyed their spirit.<sup>7</sup>

Griscom argued, then that the answer to the problem of urban diseases was a thorough cleansing of the tenement districts and a concentrated effort to maintain cleanliness. Other physician-reformers supported this belief; in 1855 Boston's Dr. Josiah Curtis stated sanitation had become the "great question of the day." With the advent of modern medicine, based on the germ theory, however, sanitation continued to play a role environmentally, but it no longer occupied center stage. Griscom's significance, therefore, goes deeper than filth removal; it rests on his basic assumption that every human being, regardless of station of life, was entitled to a clean, healthful place in which to live, work and raise a family. Underlying all this, Griscom demanded that the laboring classes be treated with dignity, which included clean ships for immigrants, spacious airy apartments, parks and trees for urbanites, and for those who broke the law, a place of confinement where they could be rehabilitated rather than broken in body and spirit. Among public health reformers of the day--John Bell, Wilson Jewell, Elisha Harris, and Isaac Parrish, to name a few--Griscom was the only one who took such a broad view of the subject, dealing with man in his several relations to society. Aware of the interrelatedness of crime, vice, overcrowded housing, poverty, pollution, and poor health, Griscom realized the futility of treating each as a separate issue. He favored an attack at the root of the problem--dehumanization. The poor, he regretted, were treated as problems, not as people. To treat them thus made matters worse; a new approach was needed, one which would see the individual as most important.

A sense of disgust pervades Griscom's major writings. In his testimony for the United States Senate select committee on immigration, Griscom wrote of the immigrants crossing the Atlantic: "There is not a fact more shocking to our sensibilities, nor more disgraceful to humanity, than the condition of these people. . . ." At another point, directing his anger against the sub-landlord who robbed and cheated his tenants at every turn, Griscom wrote of the "merciless inflictions and exhortations. . . ." Realizing that part of the problem was attributable to the lack of care on the part of the lower classes, Griscom still communicated the feeling of hopelessness of people "crushed under the pressure of all the degrading circumstances by which they are surrounded." Well conversant with the city's tenements, he found the cellars by far the worst. "It is almost impossible, when contemplating the circumstances and condition of the poor beings who inhabit these holes, to maintain the proper degree of calmness requisite for a

thorough inspection, and exercise of a sound judgment, respecting them." It was in such places that "the luckless and degraded tenants pass their nights, weary and comfortless."<sup>8</sup>

It is evident that Griscom fully accepted the reformer's duty and responsibility to improve the condition of those who suffered without cause. Several forces motivated the doctor; his father, educator and Quaker humanitarian John Griscom raised his son in the midst of reformers and humanitarian endeavors. The Quaker faith, to which both father and son clung, influenced his life work, but of equal or greater importance was his medical training. The miasmist theory gave him a belief that he could intercede on the part of the suffering classes and ease their lot in life. As a physician, he hoped to force city officials to clean the streets and landlords to disinfect their property, thereby improving the position of the poor urbanite. Another influence was of course the humanitarian spirit of the age. In his essay on the "Romantic Reformers," John L. Thomas maintains that a "dramatic disclosure of deprivation and suffering which did not tally with preconceived notions of perfectibility. . ."<sup>9</sup> moved people to reform. Thomas cites the discovery of suffering by Dorothea Dix, and in much the same way Griscom discovered suffering himself. As early as May, 1833, Griscom came in direct contact with the plight of the immigrant when he inspected a recently arrived immigrant ship. At this same time, working with the dispensaries of New York, he treated the poor in their homes, visually experiencing how the other half lived. Throughout his life he saw instances of deprivation and suffering. Taken together, these forces spurred Griscom to crawl about in unlighted, foul smelling cellars to gather accurate statistics; to go deep into the bowels of immigrant ships to experience firsthand the conditions, thus enabling him to present precise reports; and constantly to do battle with officials at the city, state, and federal level to bring about the much needed reforms.

Throughout his forty-year career John H. Griscom associated with many New York organizations. Among the more important was the New York Academy of Medicine. Griscom was one of the charter members in 1846 and continued his membership until his death in 1874. He also belonged to the New York Association for Improving the Condition of the Poor, and was responsible for its *First Report of a Committee on the Sanitary Conditions of the Laboring Classes in the City of [sic] New York, With Remedial Suggestions*. He was chosen chairman of two key committees at the 1846 meeting of the National Medical Convention, and submitted significant reports the following year. This was the predecessor of the American Medical Association, to which Griscom was a delegate and active member for several years. He was elected to permanent membership in the Medical Society of the State of New York in 1860. He served as General Agent of the Commissioners of Emigration from 1848 until 1851 when ill health forced his retirement. He was one of the early members of the New York Prison Association, serving in several important posts. He was a founder of the New York Sanitary Association and the New York Association for the Advancement of Science and Art. He was active in the New York Medical and Surgical Society, the New York Pathological Society, the New York Physicians Mutual Aid Society, and the Social



Science Association. One of his most important roles was President of the Third National Quarantine and Sanitary Convention, held in 1859. Finally, he was associated with the Juvenile Reformatory and the Home for the Friendless.<sup>10</sup>

Griscom's concern for the poor was directly limited by his medical training--he never, for example recommended higher wages for workers to allow them the opportunity to rent decent accommodations. Griscom, and many others physician-reformers who accepted the miasmist theory, refused to accept any theories (i.e., contagionism) which might lessen the impact of their attack on slum conditions and filthy environments. He and others like him were instrumental in ending many of the abuses under which the poor suffered, although this resulted in no fundamental restructuring of American society. Throughout his career he clung to his medical theory, fearing that any swing to contagionism would undermine his efforts of the past. Even as late as 1866, for example, when the New York Academy of Medicine was discussing the nature of cholera, then threatening New York for the last time, Griscom was reluctant to accept the obvious conclusion that it was contagious, and not directly related to the filth in the street. If the contagionists triumphed, he feared, then city officials would no longer be concerned with the living conditions of the poorer classes. Medically, his work is of little value today--filth per se does not cause disease--but doubtless it spurred him to reform. Along with the other reformers of the antebellum period, he was overly sanguine, believing that by simply cleaning up the slums and tenements, disease, crime, vice, and poverty would be eliminated.<sup>11</sup>

In the years prior to the Civil War many of the humanitarian reformers--including Griscom and the miasmists--accepted the concept that man was perfectible. To the miasmists this meant a clean, wholesome urban environment in which people treated one another with respect and dignity was also possible. Unfortunately the Civil War shattered the dreams of the perfectionists and the acceptance of the germ theory reduced the work of the miasmists to the realm of "environmental sanitation" rather than medicine. When the emphasis shifted from dirt and filth to bacteria and vectors, concern with urban living conditions lessened. Streets remain dirty, crime still breeds in darkened hallways, and vice lurks where overcrowding deadens moral sensibilities. Perhaps the miasmists were overly hopeful, but any move towards their goal of a clean, well-lighted and ventilated city would be a marked improvement over the then present conditions.

#### NOTES

<sup>1</sup>John H. Griscom, *The Sanitary Condition of the Laboring Population of the City of New York with Suggestions for its Improvement* (New York, 1845), *passim*. John H. Griscom, *Anniversary Discourse Before the New York Academy of Medicine, November 22, 1854* (New York, 1855), *passim*. John H. Griscom, *Sanitary Legislation, Past and Future: The Value of Sanitary Reform, and the True Principles for its Attainment* (New York, 1861), *passim*.



<sup>2</sup>George Rosen, *A History of Public Health* (New York, 1958), 194, 201-05, 208.

<sup>3</sup>Alice Felt Tyler, *Freedom's Ferment* (New York, 1962), 225. Merle Curti, *The Growth of American Thought*, 3rd Edition (New York, 1964), 360-62, 367.

<sup>4</sup>See, for example, Nathaniel Hawthorne, "The Celestial Railroad" (1843), "Fire Worship" (1843), or "The New Adam and Eve" (1843); Herman Melville, "The Tartarus of Maids" (1850), or "Pierre" (1852); Edgar Allen Poe, "The Man of the Crowd" (1840). See also Douglas T. Miller, *The Birth of Modern America* (New York, 1970), and Harry Levin, *The Power of Blackness* (New York, 1958).

<sup>5</sup>Rosen, *History of Public Health*, 104-05, 287-90, 508. Robley Dunglison, *A Dictionary of Medical Science* (Philadelphia, 1839), *passim*.

<sup>6</sup>Griscom, *Sanitary Condition*, 2-4. John H. Griscom, *A History, Chronological and Circumstantial, of the Visitations of Yellow Fever at New York, with a Supplemental Report on Yellow Fever* (New York, 1858), 22-23.

<sup>7</sup>Rosen, *History of Public Health*, 287-88.

<sup>8</sup>U.S., Congress, Senate, *Report of Select Committee On Emigrant Shipping*, 33rd Cong., 1st sess., 1853-54, Senate Report no. 386, 53-54. Griscom, *Sanitary Condition*, 6-10.

<sup>9</sup>John L. Thomas, "Romantic Reform in America, 1815-1865," *American Quarterly*, XVII (Winter, 1965), 656-81.

<sup>10</sup>Samuel W. Francis, "Biographical Sketches of Distinguished Living New York Physicians," *Medical and Surgical Reporter* (Aug. 4, 1866), 118-22.

<sup>11</sup>John H. Griscom, "The Where, The When, The Why, and The How of the First Appearance and Greatest Prevalence of Cholera in Cities," New York Academy of Medicine, *Bulletin*, III (Feb., 1866), *passim*. N.W.J., Heath, "Asiatic Cholera as It Appeared on the Steamship *England*, in April, 1866," *ibid* (Sept., 1866), 131-38.

FUNGI OF ALABAMA VI. DEMATIACEOUS HYPHOMYCETES

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INTRODUCTION

Ten further dematiaceous hyphomycetes collected in Alabama are described and illustrated.

TAXONOMIC PART

*Cacumisporium capitulatum* (Corda) Hughes, Can. J. Bot. 96:743, 1958 (Fig. 1).

≡ *Helminthosporium capitulatum* Corda, Icones Fungorum 2:13, 1838.

Colonies effuse, dark brown, hairy. Mycelium superficial or immersed in the substratum, composed of branched, septate, smooth, brown hyphae, 3-6 $\mu$  wide. Conidiophores macronematous, mononematous, straight or slightly flexuous, simple, septate, dark brown, paler distally, smooth-walled, proliferating percurrently, 190-285 X 5-8 $\mu$ , with a swollen base 12-17 $\mu$  wide. Conidiogenous cells monoblastic or polyblastic, integrated, terminal, cylindrical, percurrent, pale brown to subhyaline. Conidia solitary, acrogenous, broadly fusiform with obtuse ends, 3-septate, smooth-walled, at first hyaline, guttulate, later maturing brown with the end cells paler, 16-20 X 5 $\mu$ .

On decorticated wood, Chewacla State Park, Lee County, Alabama, March 1976, G. Morgan-Jones and P. S. Plotka, AUA.

This species, known to occur in Europe and North America, was reported by Matsushima (1975) to occur in Japan.

*Cladosporium oxysporum* Berkeley and Curtis, J. Linn Soc. 10:362, 1868 (Fig. 2).

Colonies effuse, gray, hairy. Mycelium mostly immersed, in part superficial, forming small stromata of subglobose, pale brown cells, otherwise composed of branched, septate, subhyaline to very pale brown hyphae, 3-5 $\mu$  wide. Conidiophores macronematous, mononematous, straight or slightly flexuous, cylindrical but distinctly nodose with terminal and intercalary swellings, smooth-walled, septate, pale brown, bulbous at the base, 260-480 X 3-5 $\mu$ , up to 8 $\mu$  in diameter at the swellings. Conidiogenous cells polyblastic, integrated, terminal, but becoming intercalary, sympodial. Ramoconidia present, short cylindrical, obtuse at each end. Conidia catenate, acropleurogenous, ellipsoidal, limoniiform to subglobose, subhyaline, unicellular, smooth-walled, subhyaline to very pale brown, 5-27 X 3-5.5 $\mu$ .

## Fungi of Alabama

On leaves of *Bambusa* sp., Chewacla State Park, Lee County, Alabama, April 1976, G. W. Karr, Jr., AUA.

*Codinaeopsis gonytrichodes* (Shearer and Crane) Morgan-Jones, Mycotaxon 4:167, 1976 (Fig. 3).

≡ *Codinaea gonytrichodes* Shearer and Crane, Mycologia 63:245, 1971.

Colonies broadly effuse, somewhat appressed, whitish or cream to brown as numerous conidiophores are produced, setose. Mycelium partly superficial, partly immersed, composed of branched, repent, septate, smooth, subhyaline to pale brown hyphae, 3-5.5 $\mu$  wide. Conidiophores macronematous, mononematous, scattered or gregarious in large groups, erect, straight or slightly curved, dark brown, paler distally, apex frequently very pale brown to subhyaline, producing laterally at the septa in the middle part short, encircling, somewhat nodose hyphae which occasionally grow out to form subhyaline to brown, sometimes setose branches. Conidiogenous cells mono- or polyphialidic, borne terminally on the main axis, hyaline to subhyaline, smooth, cylindrical, straight or somewhat flexuous, with an apical funnel-shaped collarette or with several collarettes as a result of the production of a number of new conidiogenous loci by sympodial proliferation, 10-19 X 3-4.5 $\mu$ , collarettes 1.5-2.5 X 1.5-3 $\mu$ . Conidia continuous, cylindrical, curved, hyaline, obtuse at each end, guttulate, with a basal scar, bearing at the apex and to one side of the basal scar a simple, curved setula, aggregated at the collarettes in mucilaginous masses, 10-15.5 X 1.5-2.5 $\mu$  long.

On dead stem of *Rubus* sp., Chewacla State Park, Lee County, Alabama, April 4, 1974, W. C. Blair, BPI, AUA.

This fungus was first described from a collection made on dried fruit of *Carya* sp., in a swampy habitat in Illinois. Two other collections were made in that state and one on submerged balsa-wood in a Maryland river (Shearer and Crane, 1971). Yokoyama (1975) reported a collection from Japan.

*Curvularia gudauskasii* Morgan-Jones and Karr, Mycotaxon 3:559, 1976 (Fig. 4).

Colonies effuse, grayish brown, hairy. Mycelium immersed in the substratum, composed of branched, septate, smooth, pale brown hyphae, 2.5-6 $\mu$  wide. Conidiophores macronematous, mononematous, sometimes somewhat fasciculate, erect, simple, straight or flexuous, cylindrical, slightly nodose distally, septate, brown, paler towards the apex, smooth, 62-98 X 5-6 $\mu$ , up to 9 $\mu$  wide at a bulbous base. Conidiogenous cells monotretic or polytretic, integrated, terminal and intercalary, sympodial, cylindrical. Conidia acropleurogenous, solitary, simple, broadly ellipsoidal to obovoid, curved, 3-septate, smooth-walled or with the walls of the lower two cells, especially the basal, minutely verruculose, brown, second cell from the apex darker and much larger than the other cells, apical cell frequently distinctly flattened at the top, basal hilum protuberant, up to 2 $\mu$  long, 27-29 X 15-19 $\mu$ .

On leaves of *Zea mays*, Auburn University Agricultural Experiment Station, Piedmont Substation, Camp Hill, Tallapoosa County, Alabama, July 1975, G. W. Karr, Jr., BPI, AUA.

A second collection of this fungus is known; on *Cyanastrum johnstoni*. Mkenke, Kigoma, Tanzania, December 3, 1964, K. A. Pirozynski, IMI 107045, AUA.

*Drechslera biseptata* (Sacc. and Roum.) Richardson and Fraser, Trans. Br. mycol. Soc. 51:148, 1968 (Fig. 5).

≡ *Helminthosporium biseptata* Saccardo and Roumeguere, Revue mycol. 3:56, 1881.

Colonies effuse, brown, hairy. Mycelium mostly immersed in the substratum, composed of branched, septate, pale brown, smooth-walled hyphae, 3-5 $\mu$  wide. Small brown pulvinate stromata sometimes formed. Conidiophores macronematous, mononematous, arising singly from swollen cells of the hyphae or in groups from the stromata, straight or somewhat flexuous, brown, paler towards the apex, septate, smooth-walled, 60-140 X 3-7 $\mu$ , slightly bulbous at the base. Conidiogenous cells monotretic or polytretic, integrated, terminal, sympodial, cylindrical. Conidia solitary, acropleurogenous, simple, straight, obovoid, 2 to 3-septate (pseudoseptate), verruculose, pale to mid brown, 22-30 X 14-16 $\mu$ .

On unidentified grass, Auburn, Lee County, Alabama, April 1976, K. Roland, AUA.

*Memmoniella echinata* (Riv.) Galloway, Trans. Br. mycol. Soc. 18:165, 1933 (Fig. 6).

≡ *Penicillium echinatum* Rivolta, Dei Parassiti Vegetali 451, 1873.

Colonies effuse, black, velvety. Mycelium mostly immersed in the substratum, composed of branched, septate, smooth, hyaline to subhyaline hyphae 2-3.5 $\mu$  wide. Conidiophores macronematous, mononematous, determinate, simple or sometimes branched, cylindrical, straight or very slightly flexuous, septate, smooth-walled or minutely verruculose, pale brown to olivaceous brown, slightly swollen at the apex, 63-92 X 3-4.5 $\mu$ . Conidiogenous cells monophialidic, discrete, in groups of 4 to 8 at the apex of the stipe, determinate, clavate, smooth-walled, bearing a very small terminal collarette, 7-9 X 3-4.5 $\mu$ . Conidia catenate, acrogenous, simple, globose or subglobose and flattened slightly dorsiventrally, verrucose, dark brown, 3.5-5.5 $\mu$  in diameter.

On leaves of *Bambusa* sp., Loachapoka, Lee County, Alabama, April 1976, G. W. Karr, Jr., AUA.

*Spadicoides klotzschii* Hughes, Fungi Canadense 8, 1973 (Fig. 7).

Colonies effuse, black, velvety. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, subhyaline to brown hyphae, 1.5-2 $\mu$  wide. Conidiophores macronematous,

mononematous, simple, cylindrical, straight or slightly flexuous, solitary or in groups of several, brown to dark brown, somewhat paler towards the apex, septate, smooth-walled, the distal half conidiogenous, 60-200 X 3-6 $\mu$ . Conidiogenous cells polytretic, integrated, terminal and intercalary, determinate, cylindrical. Conidia solitary, dry, acropleurogenous, forming through minute pores in the walls of the conidiogenous cells, simple, 2-septate, oblong with obtuse ends or obovoid, smooth-walled, brown to dark brown, upper two cells usually, but not invariably, slightly darker than the basal cell, septa obscured by dark bands of unequal width, 10-12 X 4-5.5 $\mu$ .

On decorticated wood, Chewacla State Park, Lee County, Alabama, February 4, 1976, G. Morgan-Jones and P. S. Plotka, AUA.

Hughes (1973) described this species from two collections made in British Columbia, Canada. He also indicated that it was known to him from two old European collections of unknown date housed as *Spondylocladium fumosum* Mart., in herbaria at Berlin and Geneva. The Alabama collection is the first record of its occurrence in the United States.

*Stachybotrys bisbyi* (Srinivasan) Barron, Mycologia 56:315, 1964 (Fig. 8).

= *Hyalostachybotrys bisbyi* Srinivasan, J. Indian Bot. Soc. 37:341, 1958.

Colonies effuse, gray, hairy, with salmon-pink conidial heads. Mycelium mostly immersed in the substratum, composed of branched, septate, hyaline hyphae, 1.5-2.5 $\mu$  wide. Conidiophores macronematous, mononematous, simple or more rarely branched, single or in groups of several, cylindrical, straight or slightly flexuous, hyaline, septate, smooth-walled or sometimes minutely verruculose distally, slightly swollen at the apex, 50-160 X 2.5-4.5 $\mu$ . Conidiogenous cells monophialidic, discrete, in groups of 3 to 8 at the apex of the stipe, determinate, ellipsoidal to subclavate, smooth-walled, bearing a small terminal collarette, 10-15 X 4-5.5 $\mu$ . Conidia aggregated in slimy masses, acrogenous, simple, hyaline, smooth-walled, unicellular, guttulate, limoniform or broadly fusiform, 8-14 X 5-8.5 $\mu$ .

On leaves of *Bambusa* sp., Loachapoka, Lee County, Alabama, April 1976, G. W. Karr, Jr., AUA.

This species has previously been reported from Canada, Egypt, India, Japan, Mozambique, Papua-New Guinea and South Africa.

*Stachybotrys kampalensis* Hansford, Proc. Linn. Soc. Lond., 1942-1943: 45, 1943 (Fig. 9).

Colonies effuse, gray to blackish with the production of conidia. Mycelium mostly immersed in the substratum, composed of branched, septate, hyaline hyphae, 2-3 $\mu$  wide. Conidiophores macronematous, mononematous, simple, single or more rarely in groups, cylindrical, usually straight, occasionally very slightly curved, septate, smooth, thick-walled, hyaline,

tapering distally but swelling at the extreme apex, bulbous at the base, 90-200 X 4-8 $\mu$ , up to 13 $\mu$  wide at the base. Conidiogenous cells monophialidic, discrete, in groups of 3 to 6 at the apex of the stipe, determinate, ellipsoidal, smooth-walled, 10-14 X 5.5-7 $\mu$ . Conidia aggregated in slimy masses, acrogenous, simple, dark olive-brown to blackish, verrucose, oblong with obtuse ends or somewhat ellipsoidal, biguttulate, unicellular, 11-14 X 6-7.5 $\mu$ .

On dead twig of *Hydrangea arborescens*, Chewacla State Park, Lee County, Alabama, April 1976, G. W. Karr, Jr., AUA.

This species was first discovered in Uganda (Hansford, 1943). Subsequent collections housed at the Commonwealth Mycological Institute, Kew, have been made in the British Solomon Islands, Ghana, Jamaica and Tanzania. Matsushima (1975) reported its occurrence at Osaka and Okinawa, Japan. The Alabama collection is the first record from North America.

*Tetraploa ellisii* Cooke, apud Cooke and Ellis, *Grevillea* 8:12, 1879 (Fig. 10).

Colonies effuse, brown. Mycelium superficial, composed of branched, septate, smooth-walled, hyaline to subhyaline hyphae, 2-4 $\mu$  wide. Conidiophores micronematous. Conidiogenous cells monoblastic or occasionally polyblastic, integrated, intercalary on the hyphae, cylindrical, smooth-walled, subhyaline to very pale brown. Conidia solitary, pleurogenous, dry, elliptical to long obovate, brown, thick-walled, smooth, muriformly septate, usually verruculose at the base, 30-48 X 15-24 $\mu$  with 4 to 7 transverse septa and four columns of up to eight cells, each column terminating distally in a long, subulate, septate, cellular, setiform, divergent, smooth-walled, pale brown appendage, 18-150 X 6-9 $\mu$  wide at the base, 2-4 $\mu$  wide at the apex.

On *Andropogon* sp., Chewacla State Park, Auburn, Lee County, Alabama, G. W. Karr, Jr., AUA.

#### ACKNOWLEDGEMENT

I thank the collectors cited for allowing me to study their material.

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- YOKOYAMA, T. 1975. In Descriptive Catalogue of IFO fungus collection. IV. IFO Res. Comm. 7:113-142.

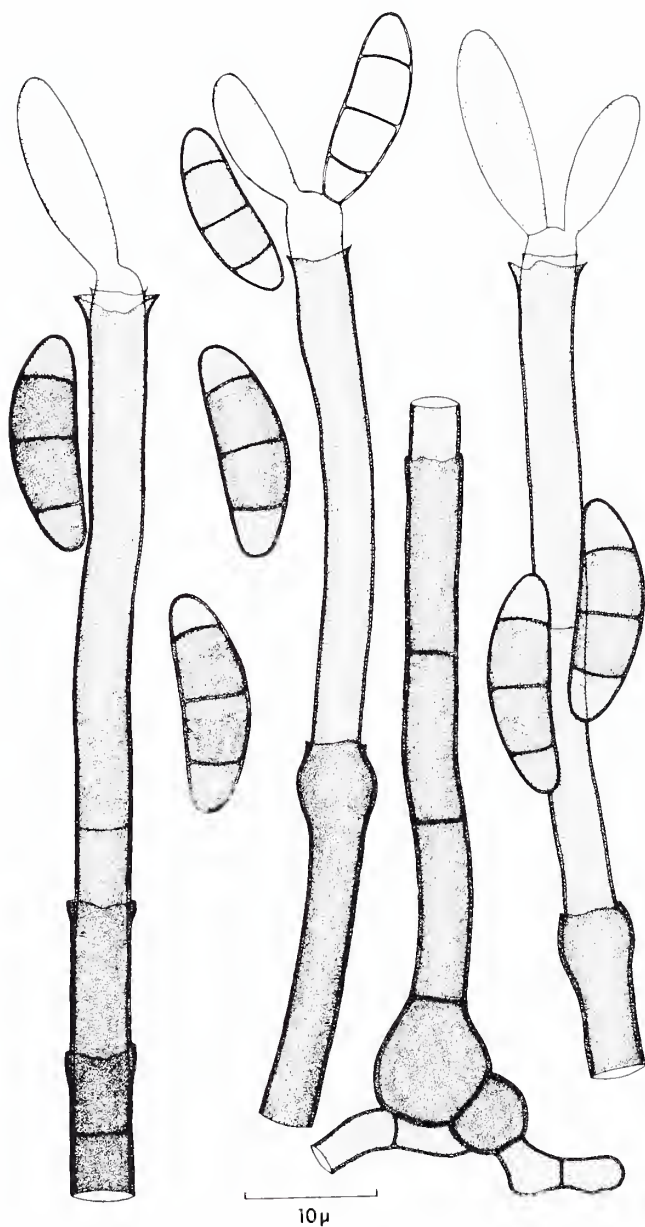


FIGURE 1. *Cacumisporium capitulatum*

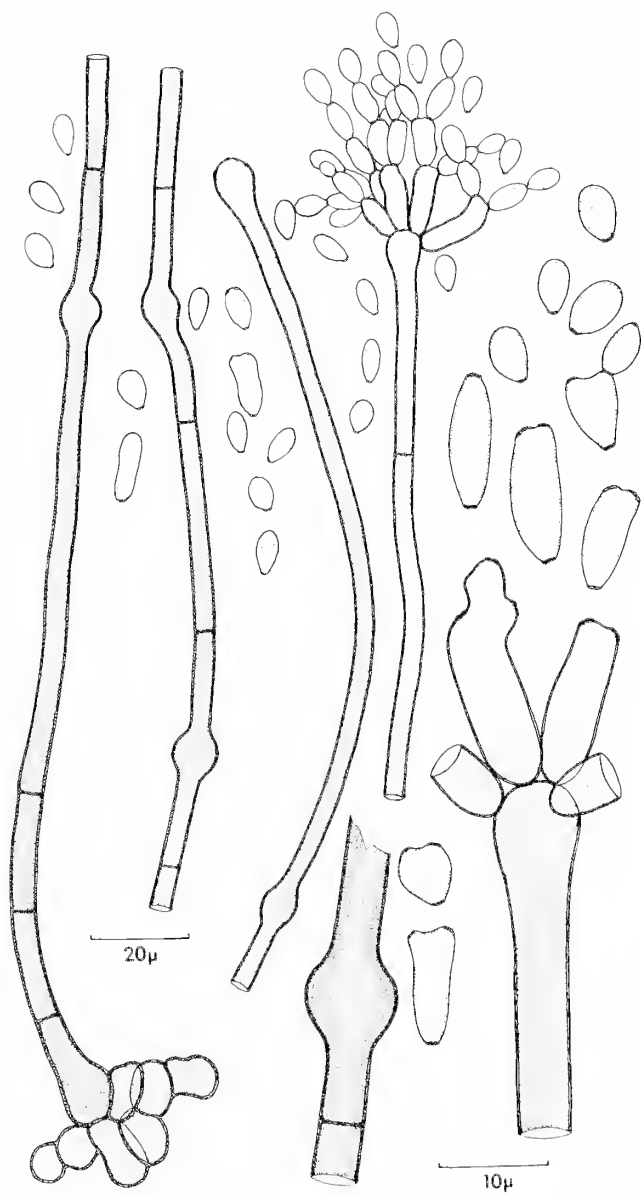


FIGURE 2. *Cladosporium oxysporum*

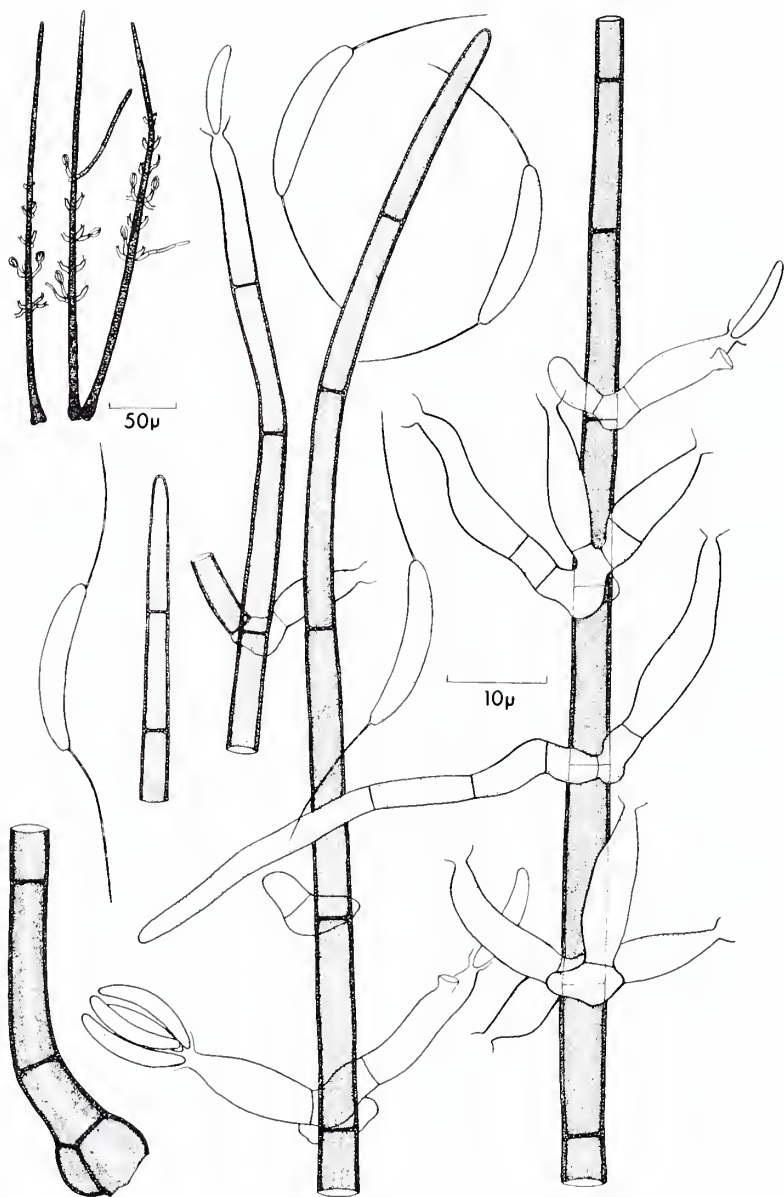


FIGURE 3. *Codinaeopsis gonytrichodes*

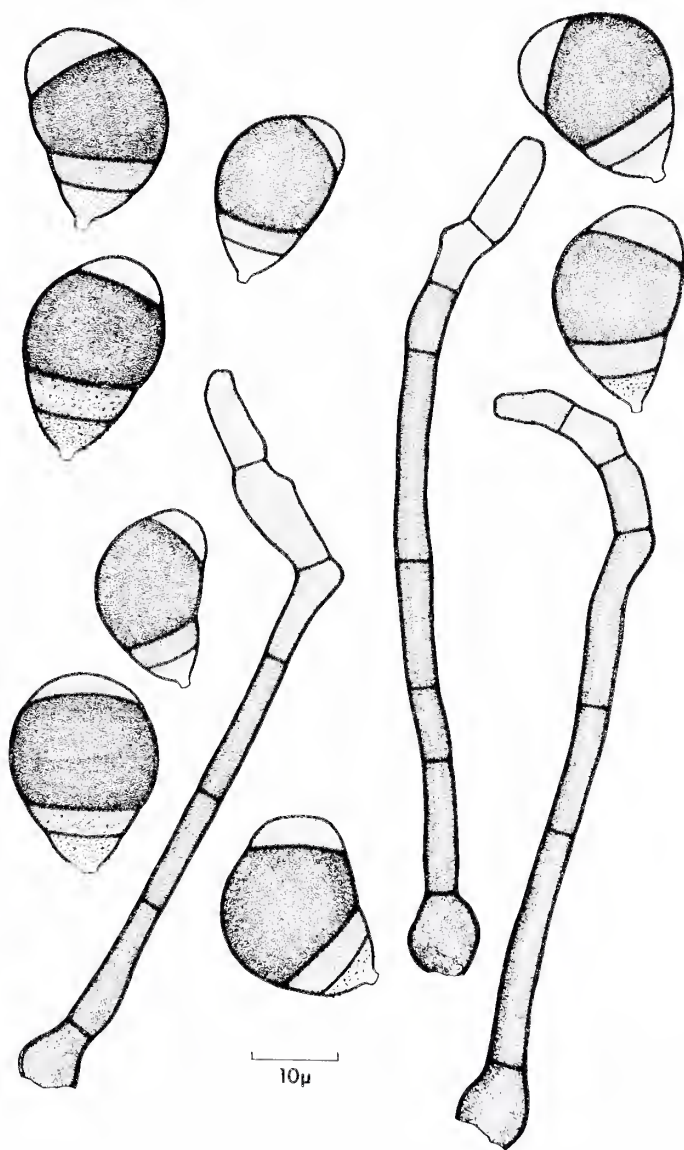


FIGURE 4. *Curvularia gudauskasii*

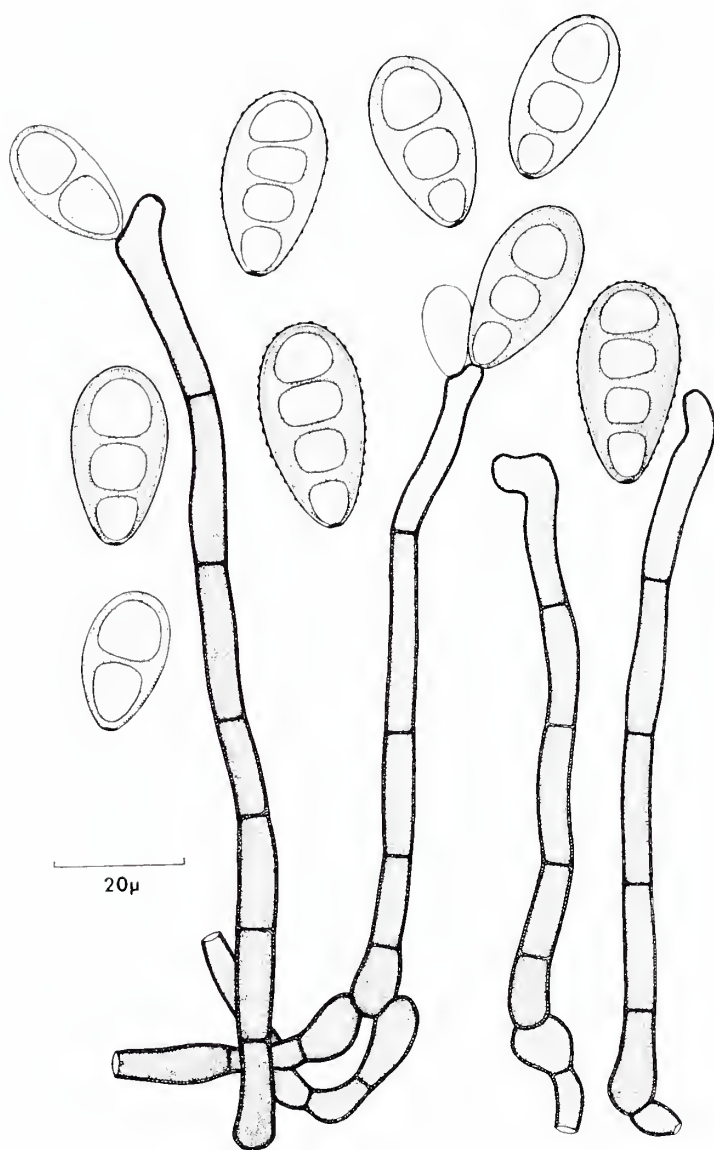


FIGURE 5. *Drechslera biseptata*



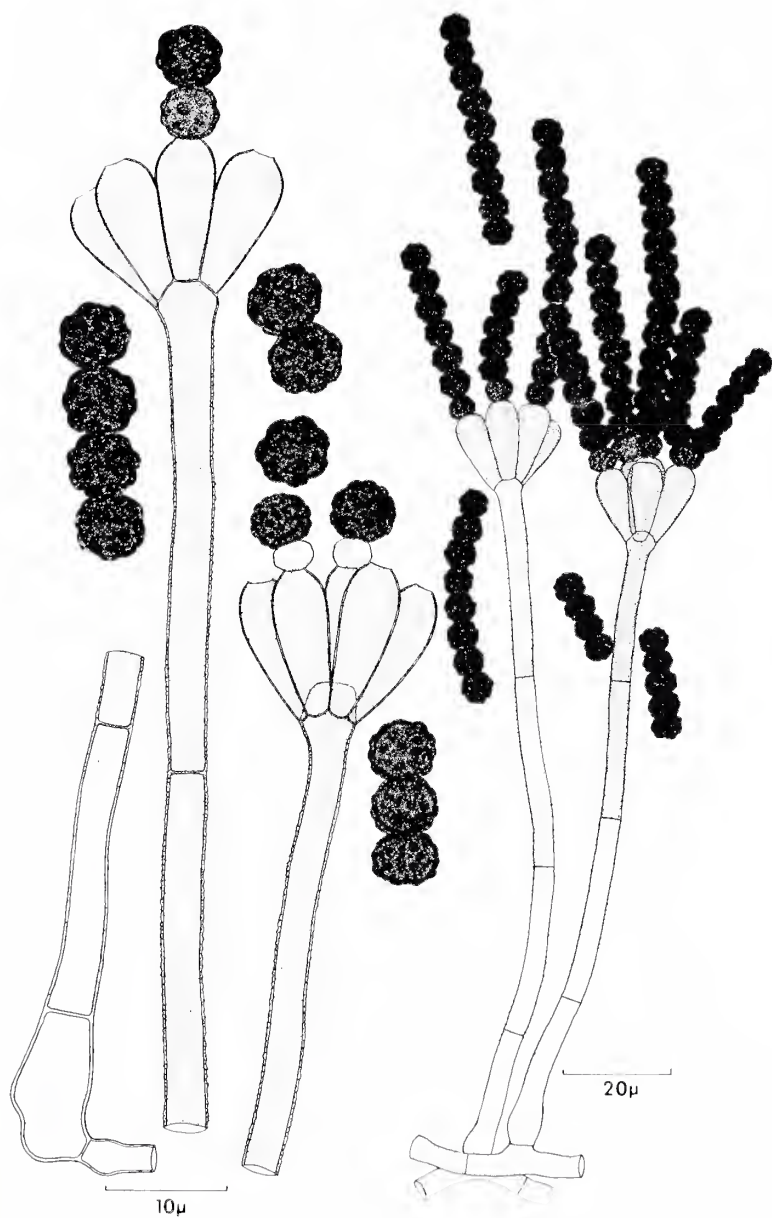


FIGURE 6. *Memmoniella echinata*

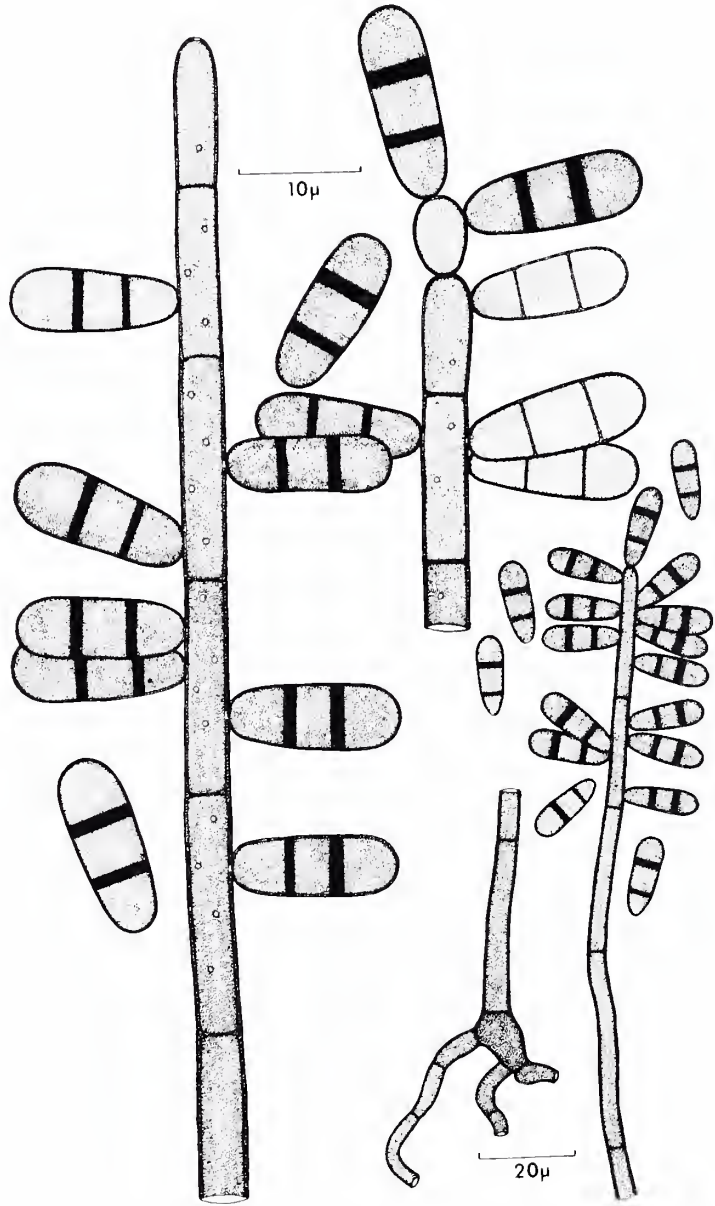


FIGURE 7. *Spadocoides klotzschii*

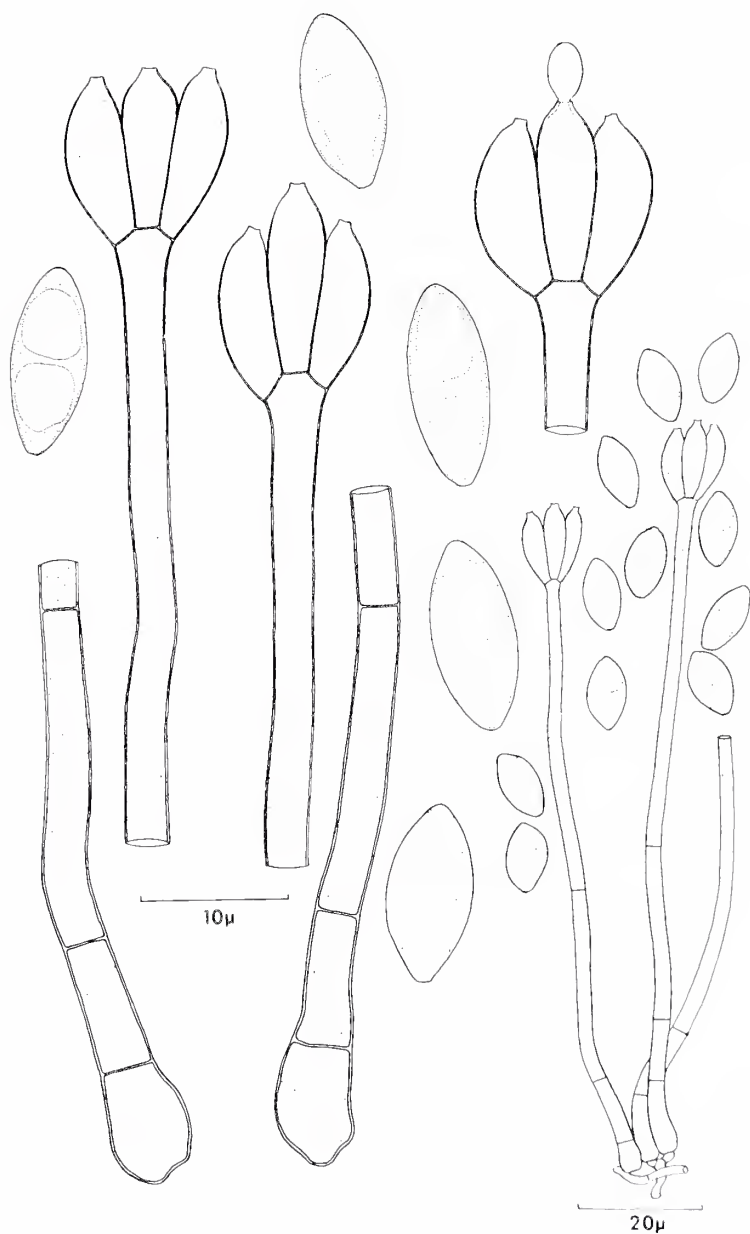


FIGURE 8. *Stachybotrys bisbyi*

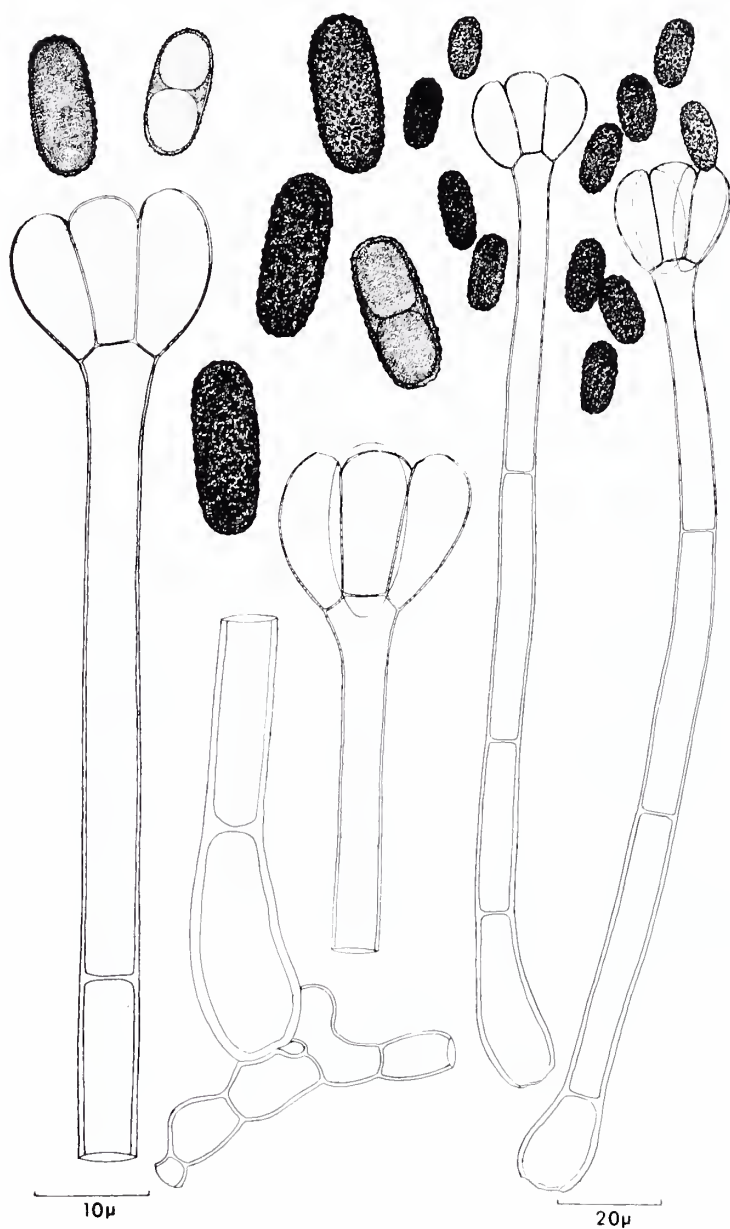


FIGURE 9. *Stachybotrys kampalensis*

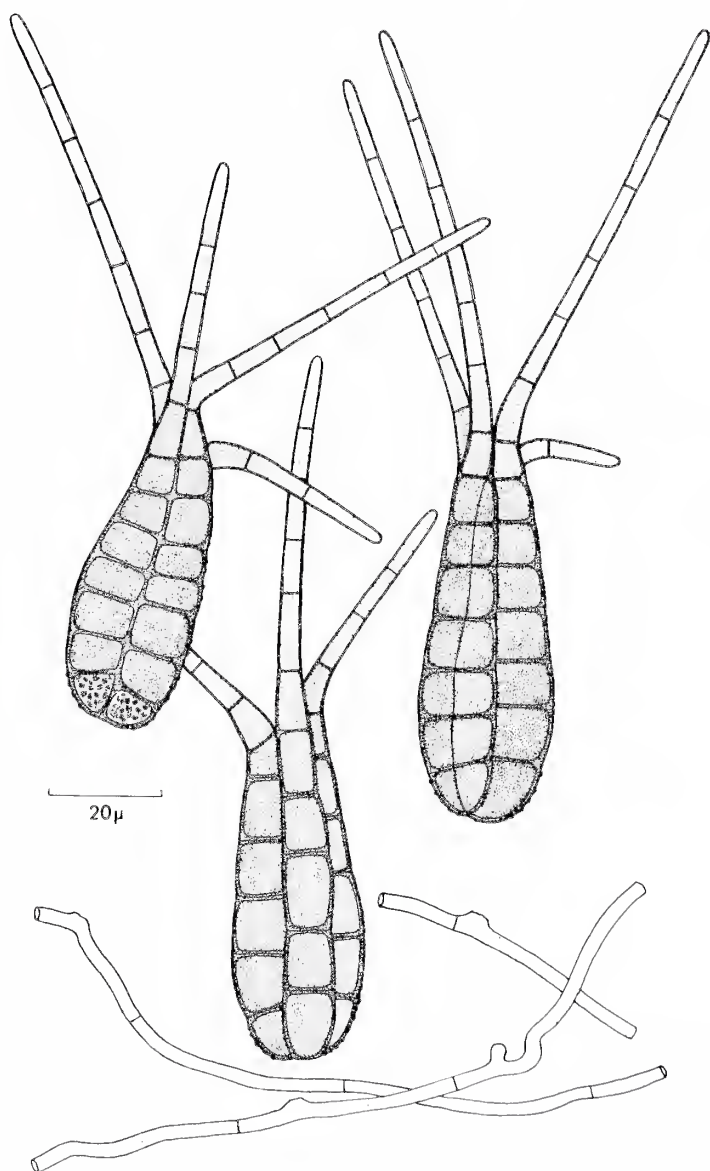


FIGURE 10. *Tetraploa ellisii*

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Publication in the *Journal of the Alabama Academy of Science* is not restricted to members, but priority is given to material submitted by members of the Academy.

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### *Tables:*

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## Notes

## Notes

## Notes

# THE JOURNAL OF THE ALABAMA ACADEMY OF SCIENCE

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KEYNOTE ADDRESS  
THE HONORABLE WALTER FLOWERS  
ALABAMA ACADEMY OF SCIENCE  
TUSCALOOSA, ALABAMA  
APRIL 9, 1977

As we begin our third century in this nation, we face one of our greatest challenges--the challenge of producing enough energy to ensure economic growth, social tranquility and national security for ourselves and future generations. In other words--the energy crisis.

We find ourselves using more and more energy and producing less. We've become more dependent than ever on foreign oil, having reached the point where we are importing half of our petroleum needs. And we're confronted with the sobering prospect that for practical purposes the world may run out of oil and natural gas by the end of the century or shortly thereafter.

Although Americans have suffered through an energy crisis in two of the past four winters--first it was the oil embargo, then the natural gas shortage--we still have no truly coordinated national energy policy --that is, a policy for conserving the resources that we do have and at the same time developing in a rational manner the new resources that we will need in the future.

Personally, I think our people are willing to make the sacrifices--economic and otherwise--that are necessary to solve the energy problem. All they are waiting for is straight talk, clear direction and decisive action on a policy that is fair and equitable.

There are some encouraging signs in Washington. The Administration has promised to submit to the Congress by April 20th important new proposals in energy policy, and all of us, of course, are eagerly awaiting that statement. There have been some strong signals on what will be the focus of the message.

From what the President has been saying, I expect there will be much emphasis on conservation and greater production and intensified usage of coal. It's unclear to me at this point what will be the bottom line on nuclear. The question of reprocessing and the breeder remains open, but the push for more conventional reactors seems assured.

We won't agree with everything the President will propose, but I think it's important that he is dealing with energy in a coordinated fashion and not in a piecemeal manner as has been the case in the past.

President Carter already has offered his proposal for a new Department of Energy, to be structured out of the functions of the Energy

Research and Development Administration, the Federal Energy Administration and the Federal Power Commission.

The majority of the members of Congress--myself included--feel that creation of an energy Department is long overdue, but there will be controversy over certain aspects of the plan.

The Congress itself has been reorganizing in an attempt to deal better with energy legislation. The Joint Atomic Energy Committee was stripped of its legislative power, the Senate created a single energy committee with enormous powers and responsibilities, and the House has drastically realigned committee jurisdictions, including the Speaker's announced new "select" committee.

As a result of the changes in the House, the Science and Technology Committee created a new subcommittee--on Fossil and Nuclear Research, Development and Demonstration. And through the good graces of my constituents in the 7th District of Alabama and the seniority system, which is still alive and well in Washington, I'm chairman of that subcommittee.

It would be the understatement of the year to say that I have a whole lot to learn in the energy field--in fact, I feel a little ridiculous being here on the platform. I ought to be out there in the audience. I'm reminded of what happened a few years back when the nomination of G. Harold Carswell to the Supreme Court was pending in the Senate. The complaint was lodged that he was then a mediocre federal judge and would most assuredly make a mediocre Supreme Court Justice. Senator Roman Hruska--defending the nomination--said "Maybe that's what we need, a little mediocrity on the Court."

We've held extensive hearings on the 1978 Authorization for ERDA, receiving testimony on all kinds of nuclear as well as fossil projects such as synthetic fuels from coal and oil shale development.

I doubt, though, that we'll try to decide on any final authorization levels or project updates until we find out exactly what the President has to say in his energy message on April 20th.

Our Subcommittee obviously exerts a lot of influence over the directions to be taken in energy research by the federal government, but I hope we can go beyond that and play a major role in the formation of the overall energy policy we've been talking about.

We've got the advantage of being able to look at various forms of energy side by side and make the necessary comparisons and trade-offs. And I think it's very important that the American people be brought in--perhaps we can help serve as a sort of public forum in this regard.

For years--the United States and the rest of the world--used energy as though it were a freely given resource. But suddenly, the availability of energy can no longer be taken for granted.

## Science and Energy Policy

Energy supply problems have disrupted daily life--they have led to bitter confrontations between various interest groups and different sections of the country, even altering the relations between industrialized nations and the developing ones, because it illuminates the world's most dangerous political issues. It wrenches into open view the national competition for resources--the festering issues of modern war.

The energy crisis forces us to make long-avoided choices.

Most people in this nation--some in high places--had no idea we even had an energy problem until 1973. That was when the OPEC countries instituted an embargo and stopped selling us crude oil. Most were astonished to learn that the United States was importing 40 percent of its annual crude oil supplies.

A great hue and cry went up. There was a lot of finger-pointing and blame-placing--but very few constructive suggestions were forthcoming.

A few clear-headed and conscientious national leaders urged the formulation of a national energy policy. It's failed thus far because of selfishness, sectionalism, shortsightedness and stupidity.

We tried to place a bandaid over a serious wound that required major surgery. We hoped it would get well. It didn't and it won't.

It took the abnormally cold weather of this winter to get our attention again. Perhaps now we will face up to the hard choices we must make to deal with this complex problem.

Recently, another aspect of the energy situation has arisen. There are people who decry the fact that America uses a large portion of the world's energy. They imply that there must be something wrong and unfair and immoral about this.

But let's remember that the abundance of energy on this continent during the first 200 years of our national history enabled the United States to build the most complex industrial society the world has ever known--to become the richest nation ever known--and the most energy dependent nation. A large portion of all energy consumed in the United States goes for agricultural production. And, because of it, America is the world's bread basket. Millions of people in scores of countries would be starving today except for the fact that Americans use a high portion of the world's energy, use it effectively, and are uncommonly generous with its product. No, we need have no energy guilt complex. To the contrary--we should have pride because of what we can do with energy. We use it intensely, and generally we use it wisely, and we use it to human benefit.

But what of the future?

We have to start with conservation. In fact, there is a good case to be made that this conservation potential is maybe our greatest

resource for the immediate future. More efficient automobiles, insulation of the nation's homes, offices, factories, better appliances and a thousand other big and little conservation moves will help enormously. Encouraging them--mandating them--makes economic and moral sense. But this conservation must be done with extreme care so as not to impair employment or obstruct the national industrial and agricultural effort, or eliminate reasonable choices of life styles among a free people.

At the same time--there is a pressing need for additional energy which must come from somewhere here in the United States--that is, if we're to avoid coming to the edge of a cliff around 2000 when the oil and gas gives out. And there is little dispute that this will happen with current rates of consumption.

We must, of course, try to improve our methods of extracting oil and gas from the earth--and we must provide incentives for a far greater effort at drilling and developing. But this will only help in a marginal way.

Hydroelectric could be increased, too, some say almost doubled--but it only provides about 2 percent of our needs now. Geothermal also could be virtually doubled--but with little real impact--in spite of pretty bad environmental results anyway.

What about solar? Solar energy is certainly a hot item in the press--and for "supplemental" heating of homes, schools, offices and hot water, it will certainly grow rapidly. But from near zero percent now it will take a monumental effort and tremendous expense for the sun to provide more than 2 percent of our energy needs in this way by the turn of the century.

Now you ask--where are all the scientific miracles we keep reading and hearing about? Gasoline producing trees and bushes? Wind energy? Tidal power? Ocean thermal gradients? Energy from wave motion? Fusion power (as opposed to nuclear fission)? Electricity directly from sunlight?

Can't we just leave our problems to the scientists and engineers--our great minds--and won't they come up with something in the nick of time?

Well, the fact is that inventions will be made; they are being made. Many of the world's greatest minds are working on these energy challenges. But even under the most miraculous of conditions new discoveries can't be tested, scaled up, proved economically feasible and environmentally compatible, and actually constructed on a scale big enough to really matter for at least TWO DECADES OR MORE. Plus the amount of capital investment required to commercialize such an energy operation would be staggering--and totally out of the question.

In short, I don't know a straight-thinking scientist or engineer anywhere who can look you in the eye and promise you a miracle of any

## Science and Energy Policy

kind--based on an invention not "yet" made or proved technically feasible that will close the energy gap for the rest of this century.

It seems to me clearly then that we have open to us only three possible courses of action--with a fourth possibility being a combination of the first three.

--(1) We can start right now to design and build 200 or 300 more large nuclear plants at a cost of about a billion each, or

--(2) If we don't want to go the nuclear route--we must start, right now, to construct 600 or more massive new coal mines with the accompanying transportation--railroads, railway cars, barges, coal slurry pipelines, etc. And we must still build massive new facilities--at a cost in the many billions of dollars--to convert this coal to electricity and other forms of energy cleanly and efficiently. Or . .

--(3) We can simply change our way of living--

? Give up the impressive social gains of recent years

? Give up on trying to improve human health standards and the quality of medical care

? Let the bulk of our work force return to the backbreaking toil of the 19th century

? Relinquish the idea of income security in old age--like other ideas made possible by our growing productivity as a nation

? Give up our cherished ideas of owning your own car, your own home

? And perhaps worst of all--we could give up the idea of a strong America with a defense capability second to none

--My (4th) option--and obviously the most appropriate--and least costly in human and environmental terms would be a variable mixture of the first three--attempting to avoid the worst and most costly implications of any one of them.

It's clear then that coupled with a STRONG DOSE OF CONSERVATION--our needed additional energy supplies for the rest of this century must come from COAL and NUCLEAR.

Looking beyond into the 21st century--and that's only 23 years off--there are four possible technologies which now seem to offer the best hope for us humans--

(1) the breeder reactor--an advanced form of fission

(2) fusion

(3) use of energy from the sun to either generate electricity, or

(4) produce fuels such as hydrogen.

These technologies will have little or no impact before 2000. In the case of the "breeder" the "know how" is there--we have the technical knowledge and certain test facilities are under way here and greater development has taken place in France, Germany and Russia.

Walter Flowers

We also have in hand much of the needed technology for solar heating--although the costs are too high still and will have to come down.

But unlike the breeder and solar heating--the technical feasibility of fusion power or of generating fuels from sunlight have not yet been demonstrated.

The potential for the future is so great that we must continue our research and development investment on what could be these "ultimate" energy sources. This will not be just a gift to future generations either because we will undoubtedly gain much for immediate application and benefit to our economy.

More than any time in the past, the choices we're making today will have a life-or-death impact on future generations. The issues are complex and the consequences of today's mistakes can be profound.

But these decisions cannot be avoided or long postponed. One thing is clear--making the decisions demands both the knowledge and careful weighing of all the facts--and not just by the so-called experts--decisions of this magnitude aren't made that way in our participatory democracy. Nor should they be made that way.

We should welcome and help build an informed electorate--an enlightened body politic.

If war is too important to be left to the Generals--as the saying goes--should the future of mankind be any less important?

Thank you.

## ABSTRACTS

Papers presented at the 54th Annual Meeting  
University of Alabama  
Tuscaloosa, Alabama  
April 7-9, 1977

### BIOLOGICAL SCIENCES

#### INHIBITION OF UTERINE RESPONSIVITY BY ACUTE DEXAMETHASONE PRETREATMENT

P. S. Campbell, C. E. Yankowsky, and H. J. Wilson  
Department of Biology  
The University of Alabama, Huntsville

The adrenal glucocorticoids inhibit estrogen stimulated water imbibition and increased membrane permeability in uterus. Thus, their antagonism of uterine growth was assumed to be a consequence of reduced precursor uptake obviating production of new cellular constituents. However, recent evidence that labilization of lysosomal membranes (which corticoids are known to stabilize) in the vicinity of the nucleus may mediate estrogen action compounds the above interpretation.

Dexamethasone, a synthetic corticoid, administered prior to estradiol significantly ( $p < .001$ ) reduced twenty-four hour uterine wet weight. Dexamethasone administration also significantly ( $p < .05$ ) reduced both 1 hour and 6 hour levels of specifically bound estradiol in the nuclear fraction of the uterus compared to the quantity observed as the result of estradiol injection alone, while no inhibitory effect of dexamethasone was observed on estradiol stimulated glucose oxidase activity. The reduction of the uterine weight response and nuclear bound estradiol was shown not to be the result of dexamethasone competition for receptor binding sites.

Since the stimulation of uterine glucose oxidase activity by estrogenic hormones appears independent of an interaction of the hormone with its receptor, these data suggest that the antagonism of corticoids on estrogen stimulated responses may be primarily mediated at the level of the genome. As the level of nuclear bound estradiol at 6 hours after estrogen injection is critical to long term uterine growth responses, its reduction by dexamethasone would most likely reduce the level of hormone stimulated transcriptional activity and consequently synthesis of new proteins involved in uterine metabolism and growth. These data also reinforce a plausible role for lysosomal involvement.



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### TOXICITY OF 3-(1,2-EPOXYPROPYL)-5,6-DIHYDRO-5-HYDROXY-6-METHYLPYRAN-2-ONE TO FIVE-DAY CHICK EMBRYOS

Leslie Perry, Joy Westmoreland, Jack H. Moore,  
and Thomas P. Murray  
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The lactone [3-(1,2-Epoxypropyl)-5,6-dihydro-5-hydroxy-6-methylpyran-2-one] was isolated from a liquid-culture medium of *Aspergillus ochraceus* Wilhelm. It was toxic to 5-day chick embryos when injected directly into the yolk-sac. The LD<sub>50</sub> was 12.5 mg/kg.

### DIFFERENTIAL SEASONAL ADRENOCORTICAL RESPONSE TO NOISE STRESS AND ACTH IN WILD COTTON RATS, *SIGMODON HISPIDUS*

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Feral *Sigmodon hispidus* were utilized in an investigation designed to detect possible seasonal variation in adrenal cortical responsiveness to noise stress and/or ACTH stimulation. Paired adrenal glands from control or noise-stressed animals collected in the Spring and Fall were incubated in the presence or absence of ACTH. Incubation media were assayed fluorometrically for corticosterone content.

Noise stress within either seasonal group significantly reduced the responsiveness of the adrenal glands to ACTH. Additionally glands from animals collected in the Fall of the year exhibited significantly lower responses to ACTH than did their Spring-collected counterparts. Finally, noise stress exerted a significantly greater effect upon diminishing ACTH responsiveness in the Fall as compared to Spring group.

The data suggest that noise stress in concert with unknown seasonal variables may act to markedly restrict the animals' ability to respond to stressful stimuli through ACTH-mediated adrenal cortical activity.

### INTERACTION OF AGING, PHOSPHODIESTERASE INHIBITION AND THYROIDECTOMY WITH ADRENAL CORTICAL ACTIVITY

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This investigation was designed to determine possible alterations in the adrenal cortical ACTH-adenylate cyclase-cyclic AMP activation system in control and thyroidectomized aging rats. Two groups of male rats, aged 60 and 340 days, were utilized. Animals were sacrificed by

decapitation, adrenal glands were removed, weighed, quartered, and placed into incubation. Glands were incubated in 2 mls. Krebs Ringer bicarbonate or in a like quantity of incubation medium fortified with either cyclic AMP, ACTH, theophylline or theophylline plus ACTH. Adrenal secretory rates of corticosterone were determined fluorometrically and glands were extracted for the radioimmunoassay of cyclic AMP.

The data suggest an age-related decline in ACTH responsiveness which may in turn be a function of elevated phosphodiesterase activity in aged animals. In turn the data suggest that elevated phosphodiesterase activity may be related to diminished thyroid hormone availability in mature animals.

### REGULATION OF PRODUCTION AND PROPERTIES OF A SMALL MOLECULAR WEIGHT PROTEASE FROM *STAPHYLOCOCCUS STAPHYLOLYTICUS*

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Lysostaphin is a protein preparation obtained from the culture filtrate of an organism in the genus *Staphylococcus* (*Staphylococcus staphylo-lyticus*). Commercially available lysostaphin contains five basic proteins. The major constituent is a glycyl-glycine and endopeptidase which is a powerful lytic agent for the cells and cell walls of other staphylococci. Two of the other proteins in lysostaphin also have enzymatic activity on cell walls, one being an acetylmuramic acid-L-alanine amidase and the other a hexosaminidase.

We have found the lysostaphin producing organism also produces a small molecular weight protease which is present in small amounts in lysostaphin along with a constitutive penicillinase. The protease has been shown to hydrolyze casein, albumin, and gelatin. The enzyme has been found to be inhibited by sulfhydryl reagents and divalent cations and to be activated by reducing agents and metal chelators, suggesting it is a sulfhydryl protease.

Ten mutants of *Staphylococcus staphylo-lyticus* which have lost the ability to produce the protease have been isolated after nitrosoguanidine mutagenesis. Each of these isolates also has lost concomitantly the ability to produce the lysostaphin endopeptidase, the hexosaminidase, and the penicillinase.

Induction and repression of the protease and endopeptidase by different amino acids and carbohydrates also have been investigated.

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### CELL WALL COMPOSITION AND LYSOSTAPHIN ENDOPEPTIDASE RESISTANCE IN *STAPHYLOCOCCUS STAPHYLOLYTICUS*

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*Staphylococcus staphylolyticus*, the lysostaphin producing organism, is unique among the staphylococci in that it is totally resistant to lysis by the glycyl-glycine endopeptidase it produces.

Biochemical tests have demonstrated that this organism is probably a coagulase-negative strain of *Staphylococcus aureus*. The organism is sensitive to the antibiotic novobiocin, gives  $\beta$ -hemolysis on blood agar, and produces a heat-stable DNase, a phosphatase, and black colonies on glycine-tellurite agar.

Amino acid analysis of the peptidoglycan of *S. staphylolyticus* indicates the organism incorporates serine in its peptidoglycan cross-bridges, presumably playing a part in the resistance of the organism to the endopeptidase. Incorporation of serine in the crossbridges of *S. aureus* strains has been shown by others to be associated with loss of coagulase production and the ability to ferment mannitol anaerobically.

Mutants of *S. staphylolyticus* which have lost the ability to produce the endopeptidase have been shown to be sensitive to lysis by this enzyme. In addition, wild-type organisms are somewhat susceptible to the enzyme prior to the onset of endopeptidase production, suggesting the endopeptidase is a constant selective pressure against the appearance of susceptible cells.

### MYCOFLORA OF ALABAMA GRAIN SORGHUM

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The mycoflora of eight varieties of grain sorghum (*Sorghum bicolor* (L.) Moench) from Camden and Prattville, Alabama was determined shortly after harvest in the fall of 1976. Samples were dried at 40-45 C, ground in an electric grinder, and plated on rose bengal-streptomycin agar in serial dilutions of 1:200, 1:2,000, and 1:20,000. Fifteen species of fungi representing nine genera were isolated from grain sorghum. *Curvularia*, *Penicillium*, and *Mucor* were the dominant genera in the eight samples. *Curvularia lunata*, *C. clavata*, and *Drechslera sorghicola* had not been previously identified to species from grain sorghum.

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### MYCOTOXIN PRODUCTION BY FUNGI ISOLATED FROM COTTON. I. TENUAZONIC ACID

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Three isolates of *Alternaria alternata* and three of *A. tenuissima* were obtained from cottonseeds and bolls and determined to be toxigenic to brine shrimp, chicken embryos, and rats when cultured on cottonseed and on YES medium. The principal mycotoxin was identified as tenuazonic acid. Five of six isolates produced this mycotoxin on cottonseed and YES medium. Maximum tenuazonic acid (266 mg/kg) was produced by *A. tenuissima* #843 on cottonseed. Its production by species of *Alternaria* commonly associated with cotton bolls is considered significant with respect to use of cottonseed meal in animal feeds.

### ENDANGERED AND THREATENED CARNIVOROUS PLANTS OF ALABAMA

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The carnivorous plants of Alabama are included in the genera *Utricularia*, *Pinguicula* (Lentibulariaceae), *Drosera* (Droseraceae), and *Sarracenia* (Sarraceniaceae). *Sarracenia alabamensis* subsp. *alabamensis*, which survives in only a few localities in Elmore, Chilton, and Autauga counties, is endangered and needs immediate protection. *Sarracenia oreophila*, occurring in northeast Alabama and in Elmore County has been listed as endangered but more realistically should be classed as threatened. Listed as currently threatened on the Alabama List are *Sarracenia psittacina* and *Sarracenia alabamensis* subsp. *wherryi* (as *S. rubra*). Both are restricted to south Alabama although *S. psittacina* occurs abundantly in other states. Two butterworts, *Pinguicula planifolia* and *P. primuliflora* have restricted distributions in south Alabama and are placed in the Special Concern category. Among the factors decimating populations of these plants are clear-cutting of forests, stream-channelization, strip-mining, farm pond construction, and prevention of natural fires.

### OXYGEN CONSUMPTION MEASUREMENTS IN STREAM SEDIMENTS

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Appropriate levels of dissolved oxygen are essential for the existence of normal flora and fauna in streams. Consequently, it represents a key water quality parameter. Although measurements of levels of

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dissolved oxygen in stream water can be made easily, it is more difficult to estimate the levels and rate of oxygen consumption in stream sediment. We have therefore initiated investigations of rate of oxygen consumption in local stream sediment. Water and sediment samples were collected above and below the discharge site of a municipal waste treatment plant and the rate of oxygen consumption was measured using a Clarke type oxygen electrode. The instrument was calibrated using the glucose oxidase system. Results indicate that this instrument provides a rapid measure of oxygen consumption rates by sediment and can be used to determine the effects of exogenous substrates on oxygen consumption rates. Future studies will be directed toward use of sediment oxygen consumption measurements to estimate the benthic contribution to oxygen consumption in streams. Possibly, estimates of times of recovery can be determined using this approach. This project has been supported, in part, by a grant from the Graduate School, University of Alabama in Birmingham.

### USE OF THE ELECTRONIC PARTICLE COUNTER FOR QUANTITATIVE ESTIMATION OF FLOC FORMATION IN *ZOOGLA* SP.

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To study the factors involved in bacterial flocculation, methods for accurately measuring the extent of flocculation under varying culture conditions, must be determined. Our investigations show that the electronic particle counter and multichannel analyzer can be used for this purpose. Data obtained includes both the numbers of individual cells and the size distributions of aggregates of cells. To determine the extent of floc formation, the number of individual, free cells in the culture is compared with the total number of cells. The total number of cells is determined by counting cells after treatment with a floc dispersing agent. Methods for dispersing floc are described. This study was supported by the Water Resources Research Institute and by the Office of Water Resources Research of the Department of the Interior as authorized under the Water Resources Research Act of 1964.

### HELMINTHS OF *CROTAPHYTUS COLLARIS COLLARIS* FROM ARKANSAS

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The fifty-seven *Crotaphytus collaris collaris* necropsied for helminths were collected by Stanley E. Trauth of Auburn University from seven Arkansas counties--Baxter, Boone, Carroll, Izard, Marion, Newton, and Stone. Nematodes were cleared with lactophenol and cestodes were stained with semichon carmine. The helminths infecting *C. collaris collaris* included immature *Physaloptera* sp. and mature *Oochoristicea* sp. The uteri of the immature female *Physaloptera* and the spicules of the

immature male *Physaloptera* were not developed. These reproductive structures are species characters and the *Physaloptera* sp. is therefore unknown. *Oochoristica* infecting *C. collaris collaris* from Arkansas may be a new species because measurements of the scolex, strobila, suckers, cirrus pouch, and testes do not approximate those measurements of species previously described in the literature.

A mixed infection of *Physaloptera* and *Oochoristica* was not observed in any *C. collaris collaris*. Thirty-two *C. collaris collaris* were infected with immature *Physaloptera* (Incidence Rate = 56.1%) and eight specimens were infected with *Oochoristica* (Incidence Rate = 14.0%). *Physaloptera* were found in *C. collaris collaris* collected in March, April, May, June, July, and August with the highest incidence rates occurring in April and July (66.7% for both months). *Oochoristica* was infecting specimens collected in March, April, May and June and the highest incidence rate occurred for June (38.5%). *Physaloptera* sp. infected *C. collaris collaris* from all counties with the exception of Stone County. *Oochoristica* was found infecting lizards from Carroll, Izard, and Stone counties.

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### NON-TARGET EFFECTS OF THREE TURFGRASS HERBICIDES

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Effects of the herbicides N-butyl-N-ethyl- $\alpha,\alpha,\alpha$ -trifluoro-2,6-dinitro-p-toluidine (benefin), 0,0-diisopropyl phosphorodithioate S-ester with N-(2-mercaptoethyl) benzenesulfonamid (bensulide), and 2-ethoxy-2,3-dihydro-3,3-dimethyl-5-benzofuranyl methanesulphonate (NC 8438) on some turfgrass pathogens and diseases were evaluated. Radial growth of *Pythium aphanidermatum*, *Rhizoctonia solani*, and *Sclerotinia homoeocarpa* on artificial medium amended with 0, 1, 2, or 10X recommended field rates of each herbicide was measured at 24-hr intervals until control plates were overgrown. Generally, growth was inhibited by most herbicide rates, and inhibition increased with increased herbicide concentration. Growth of *S. homoeocarpa* at 35C was inhibited 17, 62, and 71% by 1X rates of bensulide, NC8438, and benefin, respectively. The 1X rates of each also inhibited *R. solani* 31-41% at 18C, but at 35C benefin and NC8438 stimulated growth of the fungus 45-140%. NC8438 at 1X rate inhibited growth of *P. aphanidermatum* 34-36% at 18, 26, and 35C.

Effects on diseases were evaluated by treating pots of bermudagrass and ryegrass with 0, 1, and 3X field rates of the herbicides and then inoculating the grass with the fungi. The 1X rate of benefin increased severity of brown patch and dollar spot caused by *R. solani* and *S.*



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*homoeocarpa*, respectively, whereas, NC8438 reduced these diseases and also pythium blight caused by *P. aphanidermatum*.

### CONTROL OF BARLEY YELLOW DWARF WITH INSECTICIDES

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Barley yellow dwarf (BYD) is a viral disease of cereals and many other grasses. Typically, diseased plants are stunted and discolored. In oats, the disease is known as red leaf because of the red to purple coloration that may develop. The causal virus is spread by several species of aphids. Occurrence of BYD in Alabama had been suspected for many years but was not confirmed until 1975 when the causal virus was experimentally transmitted from diseased oat and wheat plants.

During 1975-76, effect of four systemic insecticides on incidence of BYD was evaluated in plots of 'Elan' oats. Insecticide formulations and rates (a.i./A) used were: aldicarb (Temik 10G, 1 lb), carbofuran (Furadan 10G, 1.5 lb), dimethoate (Cygon 2.67 EC, 0.5 lb), and disulfoton (DiSyston 15G, 1 lb). Aldicarb, carbofuran, and disulfoton were applied as granules at time of planting; dimethoate was applied as a foliar spray 3 weeks later. Incidence of BYD at harvest was significantly reduced by all insecticide treatments. Numbers of aphids in treated plots were lower than those in untreated plots throughout the 40-day period after planting. Yields from plots treated with aldicarb, carbofuran, and disulfoton were significantly higher than those from dimethoate-treated and untreated plots.

### EFFECTS OF CARBOFURAN ON INCIDENCE OF MAIZE CHLOROTIC DWARF AND MAIZE DWARF MOSAIC IN CORN

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Incidence of the viral diseases, maize chlorotic dwarf (MCD) and maize dwarf mosaic (MDM), was determined in corn treated with the systemic insecticide carbofuran. Plots of 'Pioneer 3369A' corn of two planting dates on the Upper Coastal Plain Substation, Winfield, AL, were treated at planting time with 1.5 lb (a.i.) carbofuran per acre and again at 30 and 60 days. The unusually heavy insecticide treatment was part of an experiment to determine corn performance when major insect pests were suppressed. Viral disease assessments were made approximately 12 weeks after planting.



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In nontreated plots of the early planting (April 9), 19% of the plants were diseased with MCD and 6% with MDM, whereas incidence in treated plots was 9% for MCD and 6% for MDM. In the later planting (June 22), 24% of the plants in nontreated plots were diseased with MCD and 13% with MDM as compared to 10% MCD and 5% MDM in treated plots. Reduction in incidence of MCD in carbofuran-treated plots was significant in both plantings as was the reduction in MDM incidence in the later planting. Yields from the April 9 and June 22 plantings of treated plots were 161 and 120 bu/A, respectively, as compared to 111 and 74 bu/A from corresponding plantings of untreated plots; yield increase for treated plots was significant for both dates of planting.

### INHIBITORY EFFECTS OF THE CHAOTROPIC AGENT $\text{NaNO}_3$ ON SEED GERMINATION

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$\text{NaNO}_3$  in concentrations ranging from .8M to .125M were used to study the effects of these  $\text{NO}_3^-$  concentrations on seed germination and on the process of plant cell protoplast fusion. Some seeds were treated after germinating root tips of 3-5mm while others were treated immediately following vernalization. Following a minimum of 7 hours treatment, samples of root tips and protoplasts were collected and prepared for routine electron microscopy.

$\text{NaNO}_3$  in concentrations of .5M to .8M promoted fusion in protoplast as evidenced by large multinucleate cells and cells in the fusion process. In concentrations of .25M and higher, the  $\text{NO}_3^-$  inhibits/or retards seed germination and root tip growth. Electron micrographs show an effect on the membranous elements of the Golgi apparatus in those seeds effected by the  $\text{NO}_3^-$ . The effect appears to be one of inducing vesiculation and dilation in what are otherwise stacks of flattened Golgi membranes.

The results from these preliminary studies suggest that the Golgi apparatus and its role in phragmoplast (cell plate) formation may serve as a model system to investigate the mechanism whereby the fusion of plant cell protoplast takes place. This would make a particularly attractive system since the fusion of Golgi vesicles at the cell plate is the origin of new plasma membrane which can subsequently participate in protoplast fusion. Experiments making use of a range of chaotropic agents are currently underway.

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### THE EFFECT OF VARIOUS TEMPERATURE LEVELS UPON THE RATE OF DEVELOPMENT OF *HELIOTHIS ZEA*

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The effect of temperature on the rate of development of the cotton boll worm *Heliothis zea* (Boddie) was determined by exposing larvae from a laboratory colony to a constant temperature from the first larval instar until pupation occurred. Each representative sample of the larvae was exposed to one of the following constant temperature levels: 64, 70, 75, 80, 86 and 91 degrees Fahrenheit. The temperature threshold was found to be 56°F and the mean day-degrees was determined to be 361.

### INITIAL CHARACTERIZATION OF A TRYPSIN INHIBITOR FROM MURINE EPIDIDYMIDES

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Various aspects of fertilization are regulated by proteinases. Acrosin, an acrosomal proteinase, functions in the penetration of the zona pellicula. Proteinase inhibitors, associated with the seminal vesicles, epididymides and testes, have been shown to disrupt the fertilization process.

We sought to isolate and characterize the murine epididymal inhibitor and determine if it is unique and separate from the known seminal vesicle inhibitor.

The epididymal factor is heat labile and a competitive inhibitor while the seminal vesicle factor is not heat labile and is a non-competitive inhibitor. The molecular weights also differ.

### OBSERVATIONS ON THE GROWTH OF A MARINE DIATOM, *CYCLOTELLA*, WHEN EXPOSED TO GIBBERELIC ACID

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The plant hormone, gibberellic acid (GA<sub>3</sub>), was found to effect the growth of a marine diatom, *Cyclotella*. Five different concentrations of GA<sub>3</sub> (5, 15, 20, 25, and 35ppm) were added to pure cultures of *Cyclotella*. An initial run was made which established an effect on the growth of *Cyclotella* by GA<sub>3</sub> with an apparent dose dependent increase in cell count. Twenty ppm showed the greatest influence.

The parameters turbidity and dry weight were monitored in addition to cell counts, using the same concentrations of GA<sub>3</sub> as stated above.

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Results obtained (in percent transmittance) showed that 20-35ppm promoted greatest growth stimulation, with 20ppm being the optimal stimulant. Less stimulation was noted at the lowest concentrations. Dry weight results were consistent with turbidity data, 20ppm stimulating the greatest growth. Thus, the parameters used revealed stimulation of *Cyclotella* by the plant hormone GA<sub>3</sub>, with 20ppm giving optimal growth in the cultures maintained.

### A FIELD STUDY OF REPRODUCTION IN THE FENCE LIZARD, *SCELOPORUS UNDULATUS*, IN CENTRAL ALABAMA

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A field study of a population of *Sceloporus undulatus* in Jefferson Co., Alabama, was undertaken to investigate the relationships between life history characteristics of a population and environmental parameters. Lizards were marked and released after recording body weight, snout-vent length, tail length, and reproductive condition by palpation. These methods revealed that adult females develop large yolked ovarian follicles by early April and remain in a reproductive condition (enlarged follicles or eggs) through July. Extensive recaptures of individual females indicate that adults lay three clutches of eggs, with oviposition periods in each of the months, May, June, and July. Hatching occurs from mid-July through September. Autopsy of 61 females from surrounding populations shows that the first clutch is larger than either the second or third ( $\bar{x} = 9.2 \pm .55$ ;  $7.9 \pm .41$ ;  $7.9 \pm .61$  eggs, respectively). The potential selective values of a larger reproductive effort during the first clutch are discussed.

Partially supported by a grant from the Graduate School, UAB.

### THE LIFE HISTORY "STRATEGY" OF THE FENCE LIZARD, *SCELOPORUS UNDULATUS*, IN CENTRAL ALABAMA

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A field study of a population of *Sceloporus undulatus* in Jefferson Co., Alabama, and autopsy data from individuals captured from surrounding populations demonstrate that Alabama *Sceloporus* have demographic characteristics considerably different from populations in more northern regions of the United States. When compared to available data from populations in Ohio and Missouri, individuals in Alabama lay more clutches and more total eggs per season, grow faster, reach maturity quicker, and have a lower survivorship. Specifically, adult females in Alabama lay three clutches per year, averaging a total of 25.0 eggs. Hatchlings grow rapidly ( $\bar{x} = 0.25$  mm/day), with some individuals reaching snout-vent lengths of greater than 60 mm by October. Nearly all females reach

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sexual maturity (60-65 mm S-V length) in less than a year, but only about one-fourth of these live to reproduce again the following season. The high fecundity, low survival life history "strategy" of the Alabama population is veiwed as a response to certain environmental parameters, such as heavy predation. Tail break frequencies ( $\bar{x}$  = 67% for females) nearly double those of Ohio and Missouri lizards support this view.

Partially supported by a grant from the Graduate School, UAB.

### MEASUREMENT OF MICROBIAL VIABILITY IN ACTIVATED SLUDGE

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With the growth of the population as well as the industrial community, the need for effective waste removal is essential. The activated sludge process utilizes bacteria to remove waste materials and may be the answer for low cost waste removal.

The efficiency of this process is dependent on the removal of waste materials by the viable bacteria. In order to insure correct plant operation it is necessary to maintain a high number of viable bacteria. Consequently, measurements of sludge viability are important. Techniques presently employed consist of simple dry weight and ash weight measurements, which may correctly reflect the viable mass. Consequently, we have initiated studies of sludge viability on both a municipal and coke waste activated sludge plants to provide a sensitive plant operating parameter. We have examined the following methods: viable plate counts, fluorescence microscopy, ATP measurements, oxygen consumption, and total microscopic counting; these methods are compared with the classical dry weight (MLSS) and ash weight measurements.

Results of the viable plate counts, fluorescence microscopy, and ATP measurements indicate a significant variation in the viability when compared with MLSS. Endogenous respiration for municipal sludge varied out of proportion with the other viability measurements. However, substrate stimulated respiration was more consistent with the other methods employed.

MLSS does not reflect the true state of sludge viability and thus the differences can be quite significant.

This study was supported by the Water Resources Research Institute and by the Office of Water Resources Research of the Department of the Interior as authorized under the Water Resources Research Act of 1964.

EFFECT OF VARIOUS CARBON SOURCES ON FLOC  
FORMATION BY *ZOOGLOEA RAMIGERA*

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Biological waste treatment provides a practical and economical method for removal of municipal and industrial wastes. At present, however, relatively little is known about some of the microbial activities that are important in the waste treatment process. For example, the mechanisms which control floc formation are poorly understood. In the activated sludge process, microbial floc formation is essential for the separation of the microbial mass from the treated water. As part of an initial study of the control of floc formation, we have examined the effect of different carbon sources on floccing efficiency. *Zoogloea ramigera* cultured in several different liquid media, including mannitol, inositol, starch, and acetamide, exhibited varying floccing efficiencies. However, an exocellular polymer, reported as being involved in floc formation, could be isolated in good yield from cultures grown on all of these media.

In liquid media containing 0.1% mannitol and 0.01% arginine, *Zoogloea ramigera* flocced extensively with floccing efficiency being optimal as the culture approached the stationary phase of growth. When 0.1% acetamide and 0.01% arginine is used as the carbon and nitrogen sources respectively, floc formation was found to be minimal and independent of the growth phase. Since floc formation can be controlled by varying the carbon source, floc forming and non-floc forming cultures can be studied by transferring cultures from one medium to another. This should provide a useful system for further elucidation of the mechanisms that control flocculation at the molecular level.

This study was supported by a grant from the Graduate School, University of Alabama in Birmingham.

STAINING OF PHYTOPARASITIC NEMATODES OF THE  
SUBFAMILY HOPLOLAIMINAE

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The use of toluidine blue solution 0.05% (p/v) in a phosphate buffer (pH 4.6; 0.05 M) was studied for staining specimens *in toto* of *Hoplolaimus galeatus* and of *Helicotylenchus dihystera*. Staining for 7 hours at 60 C gave good general staining. When stained specimens were washed for 5 hours at 55-60 C in phosphate buffer good differentiation was observed between the esophageal region and the reproductive apparatus in females and males. Satisfactory results were also obtained at low temperatures but with increased time of exposure.

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### EFFECTS OF THE FUNGICIDES BENOMYL AND FENTIN HYDROXIDE ON PLANT PARASITIC NEMATODES

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Technical benomyl and fentin hydroxide were applied at rates from 0 to 100 mg/kg to a sandy loam soil infested with root-knot (*Meloidogyne incognita*), stunt (*Tylenchorhynchus claytoni*), lance (*Hoplolaimus galeatus*), and saprophagous nematodes. Treated pots of soil were either planted with "Rowden" cotton or left unplanted and placed in the greenhouse; there were 8 replicates per treatment. After 4 weeks, soil samples were taken from all pots, and in planted pots roots were washed and assessed for galling. In cotton-planted pots the following results were recorded: Benomyl increased gall densities by 94% at 50 mg/kg; a 35% increase and a 66% reduction in numbers of stunt nematodes occurred at 2.5 and 10 mg/kg, respectively; lance nematodes showed a 69% and 95% reduction at 30 and 50 mg/kg; and saprophagous nematodes were not significantly affected by benomyl treatment. Also, fentin hydroxide increased gall densities by 80% at 5 mg/kg with a 95% reduction at 40 mg/kg; a 270% increase in numbers of stunt nematodes occurred at 10 mg/kg; and numbers of lance and saprophagous nematodes increased by 166% and 132% at 40 and 2.5 mg/kg, respectively. In pots not planted with cotton, the following results were recorded: Effects of benomyl on stunt and lance nematodes were similar to results for cotton-planted pots. In contrast, however, saprophagous nematode numbers were reduced by 88% at 10 mg/kg. Fentin hydroxide did not significantly affect numbers of stunt nematodes, but significantly reduced lance nematodes by 70% at 50 mg/kg. Saprophagous nematodes were reduced 45% and 81% at 10 and 40 mg/kg, respectively.

### A TOXICOLOGICAL STUDY IN WHITE LEGHORNS USING CORN MOLDED WITH AUBURN STRAIN AUA-532 *PENICILLIUM CITRINUM*

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Two replicates of 10 chicks each of day-old White Leghorns were fed rations containing 0, 3.88, 7.75, 31 and 62% *Penicillium citrinum* moldy corn rations for five weeks. The 31% and 62% dose levels significantly depressed body weight throughout the five-week period. Eighty-five percent of the 62% dose level birds and 20% of the 31% dose level birds had died by the end of five weeks. Pathological findings were atrophy of the pectoral muscles, heart, spleen, liver, and kidney. The gallbladder was distended and the bone marrow had many deposits of fat. Duplication of the experiment, however, with heavier infestations of *P. citrinum* caused a ten-fold increase in toxicity. Chicks fed a 62% dose level of this corn in the ration were all dead by seven days. The chicks had hemorrhaging in the intestines, spleen, kidney, and skeletal muscles.



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The U.V. analyses of this compound were similar to citrinin, and TLC analyses of the moldy corn for citrinin indicated the presence of 50 ppm of citrinin. Mass spectral data, however, showed a larger molecule than citrinin and no molecular ion peak was detected at 250. Citrinin was thus not completely confirmed. Preliminary feeding trials in chickens with pure citrinin showed that up to 260 ppm of dietary citrinin caused no toxicity comparable to that observed with the *P. citrinum* moldy corn ration. A review of the literature on citrinin shows conflicting reports of toxicity or lack of toxicity of citrinin and indicates there may be several forms of citrinin or several closely related compounds which appear to be citrinin when analyzed by TLC or U.V., but which have widely differing toxicities. Whether the toxicity seen in this study is due to one of these compounds is unknown at this time.

Analysis of the *P. citrinum* moldy corn for aflatoxin was negative, although a blue fluorescent compound with the same R<sub>f</sub> as aflatoxin B<sub>1</sub> was observed. It is possible that a compound similar to aflatoxin or a bound form of aflatoxin is present. *P. citrinum* was reported by Kulik and Holaday to produce aflatoxin, though this work was not confirmed.

### A COMPARISON OF HELMINTH PARASITES OF THE SUNFISH FAMILY (CENTRARCHIDAE) IN THREE MICHIGAN LAKES

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Various environmental factors were considered in their influences on the presence or absence of helminth parasites infecting the Centrarchidae of three closely situated Michigan lakes. The data include the physical factors of the lakes, the vegetation present, the fauna available as definitive and intermediate hosts, and the incidence of parasitic infection in those hosts. The variety and numbers of parasites found in the centrarchids is explained in consideration of these factors.

The lake with the greatest incidence and variety in the number of parasites also showed the greatest variety of definitive and intermediate hosts and the least eutrophication. The lakes with the least incidence of parasitism had few hosts available for completion of the life cycle. As eutrophication continues in these three lakes a reduction in the number and variety of hosts and parasites is expected. The data suggest that parasite populations may be an indicator of biotic wealth in a community.



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### A STUDY ON THE DISTRIBUTION OF *ETHEOSTOMA OKALOOSAE*, THE OKALOOSA DARTER, AND *ETHEOSTOMA EDWINI*, THE BROWN DARTER, IN NORTHWEST FLORIDA

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The Okaloosa darter, an endemic species to the Choctawhatchee system in northwest Florida, was placed on the official list of endangered species in 1973 because of concern over habitat destruction in the streams occupied by it and also possible competition with the brown darter, its nearest relative. In 1975, the U.S. Fish and Wildlife service funded a one-year study on the Okaloosa darter. The primary goals of this study were to determine the extent to which the brown darter had invaded the range of the endangered form and to evaluate the effects of its presence there.

Six field trips were made to Florida during which 63 collections were made at 43 stations. A total of 3,374 specimens comprising 30 species and 16 families of fishes were collected. Two hundred fifty individuals of the Okaloosa darter were collected of which 21 percent (53) were retained for museum specimens. Three hundred forty-five specimens of brown darter were recorded from 15 stations, 10 of which are herein reported for the first time. Examination of collection data from a 9- to 12-year period at four sites on Okaloosa darter streams indicates that the endangered form is being replaced by the introduced brown darter population.

### OBSERVATIONS ON THE OVARIAN DEVELOPMENT OF SMALLMOUTH BASS IN PICKWICK RESERVOIR

Wayne A. Hubert and Vester P. Mitchell, Jr.  
Tennessee Valley Authority

The sexual maturity and seasonal ovarian development of 202 Pickwick Reservoir smallmouth bass were evaluated. A few fish were found to be sexually mature at three years, but most did not reach sexual maturity until their fourth year. Sexually mature smallmouth bass contained ova in several stages of development prior to spawning. Two distinct size groups were observed; only a portion of the largest size group became fully ripened at one time. Following the spawning season residual ova were resorbed during the summer and renewed ova development was observed in September. Throughout the ova maturation process larger females were advanced over smaller, sexually mature fish. Smallmouth bass were found to produce larger ova, but a smaller number per unit of total length, than either the largemouth bass or spotted bass.

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### PROBLEMS IN THE SYSTEMATICS OF SOUTHEASTERN TARDIGRADES

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Data obtained by examination of 117 specimens of *Echiniscus quadrispinosus brachyspinosus*, collected from four widely separated localities, suggest that this variety does not represent juveniles of *E. q. quadrispinosus*, as previously suggested by Cuenot and Rammazzotti. *Echiniscus q. brachyspinosus* is geographically and morphologically distinct from the nominate form and may represent a subspecies or a distinct species. Additionally, the nominal species *Echiniscus virginiscus* Riggin is apparently identical to *Echiniscus quadrispinosus brachyspinosus* and is here placed in the synonymy of the latter.

### RADIONUCLIDE EXCRETION AND METABOLIC RATE IN FLATWORMS

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*Dugesia tigrina* (Griard) was labeled with  $^{65}\text{Zn}$  by both direct absorption and feeding techniques. Bioelimination curves were erected for groups of individuals held at 18°C and 28°C, and biological half-life determinations were made on the basis of whole-body counts taken after an initial rapid loss of the nuclide. Animals labeled by both methods eliminated the nuclide at very similar rates when held at the same temperature. Animals held at 28°C eliminated the nuclide approximately 3.5 times as rapidly as those held at 18°C. Individuals are readily labeled with  $^{65}\text{Zn}$  and our data shows that the nuclide's elimination rate is directly correlated with metabolic rate.

### OBSERVATIONS ON THE BREEDING ECOLOGY OF THE TIGER SALAMANDER, *AMBYSTOMA TIGRINUM*

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Several aspects of the breeding ecology of the eastern tiger salamander were studied at a temporary pond located in southern Macon Co., Alabama. Phenomena associated with the breeding migration were studied using a drift fence with pitfall traps designed to completely encompass the pond. Migration was initiated by a combination of rainfall and temperature. Salamander recapture data suggest orientation of the individuals to certain entry and exit corridors around the pond.

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The breeding population comprised 151 individuals (83 males and 68 females). Variation by sex existed in weight (males 31.7 g, females 36.5 g) but not in length (males 106.4 mm Snout-vent, females 105.0 mm).

Breeding occurred twice during the four month period on 7 December 1975, and 1 January 1976. Egg masses were located on supports 15-30 cm below the surface in 30-60 cm of water, in areas of the pond with little or no emergent vegetation. Average number of eggs per mass was 33.05 (N = 40; R = 9,70). Reproductive effort in the pond totaled 2115 eggs.

Causes of mortality included predators, both on eggs and larvae, diseases that killed the eggs of fungal and bacterial infestations, and climatic factors, especially fluctuating water levels in conjunction with extremes of temperature. During the study period, mortality was assumed to be 100% since no transforming individuals were captured in the pond or while exiting from it.

### A RESURVEY OF THE ICHTHYOFAUNA OF CEDAR CREEK

Vester P. Mitchell, Jr., William H. Host, Jr., and Paul Yokley, Jr.  
Tennessee Valley Authority

Cedar Creek drains an area of some 616 Km<sup>2</sup> in northwest Alabama. Four collections from nine stations revealed the presence of 40 species representing 11 families of fish. New records of *Moxostoma anisurum*, *Moxostoma duquesnii*, *Pimephales vigilax*, *Noturus miurus*, *Percina sciera*, *Percina evides*, *Percina shumardi*, *Etheostoma flabellare*, *Aplodinotus grunniens*, and *Angiulla rostrata* were obtained for the Cedar Creek drainage.

### POSTNATAL TESTICULAR DEVELOPMENT IN THREE INBRED STRAINS OF MICE

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Postnatal testicular development was studied in 3 inbred strains of mice; SJL/Dg, BALB/cDg and C57BL/10Dg. Testes development in all strains exhibited logistic growth. The testes of C57BL/10Dg mice reach maximum size in the shortest time. BALB/cDg, on the other hand has the slowest rate of testes growth and take longer to reach maximum size. The SJL/Dg strain is intermediate. The difference in testicular development of these strains may have a hormonal base.

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### PLASMA STERIOD LEVELS DURING THE OVULATORY CYCLE OF THE QUAIL *COTURNIX COTURNIX JAPONICA*

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Peripheral plasma samples were collected at 0600, 1200, 1630, and 2200 hours from laying Japanese quail (*Coturnix coturnix japonica*) which had been maintained under a constant photoperiod of 16 hours light. Plasma samples of 100  $\mu$ l were then assayed for estradiol and progesterone by means of radioimmunoassay. Progesterone levels reached a peak of  $912.5 \pm 304.2$  Pg/ml at 1200 hours. Estradiol also tended to show a peak at this time in the majority of samples. When the data of birds with an estradiol peak at 1200 were pooled, a peak of estradiol ( $194.8 \pm 61.6$  Pg/ml) was more pronounced. The ranges of estradiol levels seen here were very similar to values reported in the domestic hen although progesterone in the hen was almost twice the peak obtained in the present study. Ovulation was seen to occur regularly between the hours of 1430 and 1630, therefore these steriods peaked some 4 to 5 hours before ovulation. A similar peak of steriods 4 to 5 hours before ovulation has also been reported in the domestic hen. Whether these steriod peaks are caused by LH remains to be determined.

### IMMUNOLOGICAL STUDIES OF AVIAN PROLACTIN

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Chicken pituitaries were extracted using the Scane's *et al.* method to obtain the prolactin fraction. This pituitary fraction was found to have electrophoretic mobility similar to ovine prolactin in a Polyacrylamide gel electrophoresis system. Similar banding was found in a crude homogenate of sparrow pituitary. Both the chicken pituitary prolactin fraction and the crude sparrow homogenate failed to crossreact with rabbit-Anti-Ovine Prolactin in an immunoelectrophoretic system and in an Ouchterlony Double diffusion. Although avian and ovine prolactin are similar in electrophoretic mobility, these data indicate that the immunoreactive properties of these prolactin molecules are dissimilar enough to disallow their use in a heterologous radioimmunoassay.

### THE DESCRIPTION OF TWO PARAMETERS IN COLOR DISCRIMINATION IN *NOTROPIS SIGNIPINNIS* (BAILEY AND SUTTKUS)

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*Notropis signipinnis* (Bailey and Suttkus), a freshwater schooling minnow with striking, red coloration, was used in our investigation. Two

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parameters were monitored: behavioral, eliciting a conditioned response to colored lights; and biochemical, extracting and analyzing retinal pigments.

Two communities with eight *N. signipinnis* in each were used in the behavioral experiment. One group had feeding paired with blue light and the other had feeding paired with red light. The group trained to red light exhibited the conditioned response while the group trained to blue light did not.

The visual pigments extracted from the retinae of ten *N. signipinnis* were pooled and the absorbance at varying wavelengths measured. The extract had maximal absorbance in the extremes of the visible spectrum, at 400 and 780 nm. The peak of absorbance in the blue wavelengths (400 nm) was narrow, while the peak in the red (780 nm) was high and broad.

The behavioral and pigment extraction experiments indicate that *N. signipinnis* can distinguish red light. However, the results are inconclusive as to whether they can or cannot distinguish blue light.

## ENDANGERED AND THREATENED PTERIDOPHYTES OF ALABAMA

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Alabama has a rich pteridophyte flora, but a great many species are rare. The recent publication "Endangered and Threatened Plants and Animals of Alabama" contains several mistakes, mostly in nomenclature, and numerous omissions. The report lists four species as endangered--*Leptogramma pilosa* var. *alabamensis*, *Trichomanes boschianum*, *T. petersii* and *Selaginella riddellii* (erroneously listed as *S. tortipila*); six as threatened--*Asplenium bradleyi*, *A. ebenoides*, *A. ruta-muraria*, *Lycopodium porophyllum* (not "porophyllum"), *Chelanthus alabamensis* and *Lygodium palmatum*, and five as species of special concern--*Isoetes melanopoda*, *Lycopodium cernuum*, *L. flabelliforme*, *Ophioglossum crotalophoroides* and *Polypodium virginianum*.

The addition of twelve species to the endangered list in Alabama is proposed--*Asplenium gravesii*, *A. trudellii*, *Cystopteris fragilis*, *C. tennesseensis*, *Dicranopteris flexuosa* (possibly already extinct in Alabama), *Dryopteris australis*, *D. campyloptera*, *D. cristata*, *D. spinulosa*, *Equisetum arvense* and *Marsilea mucronata*; four are considered threatened--*Athyrium thelypteroides*, *Dryopteris goldiana*, *Lycopodium lucidulum* and *L. obscurum*; and nineteen are considered to be species of special concern--*Athyrium pycnocarpon*, *Botrychium alabamense*, *B. lunarioides*, *Dennstaedtia punctilobula*, *Dryopteris celsa*, *D. intermedia*, *B. ludoviciana*, *Isoetes butleri*, *I. engelmannii*, *I. melanospora*, *I. piedmontana*, *Lycopodium tristachyum*, *Osmunda claytoniana*, *Selaginella ludoviciana*, *Thelypteris dentata*, *T. ovata*, *T. quadrangularis* var. *versicolor*, *Ophioglossum engelmannii* and *O. nudicaule*. Several taxa in each category are not as rare in other parts of the United States as they are in Alabama.

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The state lies just barely within the extreme limits of their ranges. Thus, a species such as *Equisetum arvense*, which is fairly common in the Northeast but is known in Alabama from only one locality, should be considered endangered in this State.

### *RATTUS NORVEGICUS*, S.A.F./S.D. AND TUMOR RESEARCH ON THE UNDERGRADUATE LEVEL

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I have found the rat strain S.A.F./S.D. (Southern Animal Farm/Sprague Dawley) of *Rattus norvegicus* ideally suited for undergraduate research with tumors. I have studied the occurrence of spontaneous pseudo-encapsulated fibrosarcomas in this strain and have found that of 12 cases of spontaneous malignant mammary tumors examined 11 were in fact pseudo-encapsulated fibrosarcomas. The 91.6% occurrence rate for such tumors is very high and serves well for observational and statistical studies conducted by undergraduate students. This strain also lends well to operative procedures performed by undergraduate students. Bilateral adrenalectomies, splenectomies, spleen-to-ovary auto and cross transplantation, ovariectomies, ovary-to-spleen auto and cross transplantations, orchidectomies, spleen-to-testes auto and cross transplantation and adrenal transplantations; all of these procedures were performed and the S.A.F./S.D. strain served as an excellent research animal in all procedures. After four years of experience and research with this strain of rats I would recommend it to be investigated further as an excellent test animal for future undergraduate tumor research.

### ONTOGENETIC DEVELOPMENT OF PIGMENTATION IN A PIGMENT-DEFICIENT LARVAL *RANA HECKSCHERI* (ANURA: RANIDAE)

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Most amphibians possess three types of epidermal and dermal chromatophores: xanthophores, guanophores and melanophores. Normally, these are fully distributed and well-developed very early in larval development. In the river frog, *Rana heckscheri*, melanophores comprise the majority of cells responsible for pigmentation and color changes. In November, 1975, a pre-metamorphic larval *R. heckscheri* was captured at Emerald Springs, Bay County, Florida, which appeared on initial inspection to be an albino. The specimen was returned to our laboratory, placed in a 10-gallon aquarium, and reared through metamorphosis to the adult form. Shortly after capture a light suffusion of dark pigment was noticed in the dorsal and ventral borders of the tail fin, the tip of the tail musculature, and in the anterior head region between the eyes and mouth. These changes appeared at approximately the same time as the emergence of the hind limb buds. At the completion of metamorphosis, dorsal pigmentation had developed to such an extent that the specimen



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was within the range of normal variation for members of the species. The ventral surface, however, was abnormally light. To our knowledge, observations concerning abnormally delayed development of pigmentation have not been previously reported in a larval anuran.

### THE FINE STRUCTURE OF SPERMATOOZOA OF *STERNOTHAERUS* *MINOR MINOR* (CHELONIA: KINOSTERNIDAE)

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An elongated acrosome with a pronounced anterior curvature is present. A prominent subacrosomal space separates the acrosome from the nucleus. The nucleus contains a central invagination which extends to the posterior margin of the acrosome. The head articulates with the midpiece portion of the tail by a capitulum. The proximal centriole lies at a right angle to the tail. The distal centriole, embedded in a dense matrix, has two additional tubules. The axial filament of the midpiece is also associated with a dense matrix. Mitochondria, as individual organelles, are composed of loosely-organized whorls of double membranes. Five mitochondria are evident in cross-sections and eight to ten in longitudinal sections of the midpiece. The junction between the midpiece and principle piece is demarked by an annulus. The axial filament of the principle piece is surrounded by a fibrous sheath. The fibrous sheath terminates at the juncture of the principle piece and end piece. The axial filament of the principle piece and end piece has the typical 9 + 2 arrangement of microtubules.

## GEOLOGY

### HUMATES IN THE TOMBIGBEE SAND, MONTGOMERY, ALABAMA

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Humates are common features of modern coasts located within 40 degrees of the equator. However, humate is seldom recognized in coastal sands that are older than Pleistocene. Six varieties of humate sands in Florida and Alabama were recognized and classified. One variety is characterized by discontinuous lenses in high-angle cross-beds. A probable ancient analog can be observed in the Tombigbee Sand exposure at the Montgomery Industrial Terminal locality. Geologic evidence strongly suggests that this ancient humate-like deposit is a humate-derived carbonaceous deposit. However, the carbonaceous material from the black sand-coatings has properties that are different from those of modern humates. The combusive, solubility, and oxidation states are sufficiently different to indicate major diagenetic changes.



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### PROBABLE ORIGIN OF THE TOMBIGBEE SAND, EUTAW FORMATION, MONTGOMERY, ALABAMA

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The Upper Cretaceous sediments in Alabama are subdivided into three stratigraphic units: the basal Tuscaloosa Group, the intermediate Eutaw Formation, and the overlying Selma Group. One interesting exposure of the Eutaw Formation in West Montgomery is in the Tombigbee Sand Member. It is known as the Industrial Terminal exposure and represents a sequence of coastal sands. Fifteen feet of the exposure consists of cross-bedded, fine-grained, glauconitic sands with angles of dip indicative of subaqueous avalanching migration. The cross-bed sets are divisible into large-scale planar, small-scale planar, and trough-type sets. Paleocurrent analysis reveals three current directions: a strong longshore current to the northwest, a flood tidal current to the north and a weak bimodal tidal current which was northeast and southwest. Grain size analysis reveals a mode of 1.8  $\phi$  in a well sorted, fine skewed sand. The fauna includes *Callianassa major*, several *Hardouina* echinoid species, *Trigonia*, and *Gryphaea*, as well as some problematical V-shaped and spiral burrows. There are four common depositional environments in which high-angle large-scale cross-strata are observed: tidal deltas, offshore bars, barrier islands and spit platforms. Of these four environments only spit platforms and flood tidal deltas commonly display tabular cross-beds, rapid accretion, and tidal current transport.

### THE GEOLOGY OF PART OF THE DADEVILLE COMPLEX-- A PROGRESS REPORT

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Four lithologic units (Agricola Schist, Ropes Creek Amphibolite, Camp Hill Gneiss, and Doss Mountain Complex) are recognized near Camp Hill in the Dadeville Complex of Alabama's Inner Piedmont. Two periods of folding are evident on a mesoscopic scale: (i) northeasterly and southwesterly plunging isoclinal folds; and (ii) northerly plunging open folds. Outcrop patterns of the Agricola Schist, Ropes Creek Amphibolite and Camp Hill Gneiss suggest that the area suffered macroscopic folding along axes parallel to those of the mesoscopic isoclinal folds. The dominant metamorphic event, which was synchronous with the early mesoscopic isoclinal folding, raised the pelites of the Agricola Schist to the kyanite and sillimanite zones of the Barrovian (moderate pressure) Facies Series. The Doss Mountain Complex consists of several layered intrusions, each intrusion containing gabbro, norite, pyroxenite and metagabbro.

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STATISTICAL ESTIMATION OF COAL RESERVES

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Statistical methods used in economic geology often are inefficient. Improvements in statistical techniques may be easier and less expensive than obtaining the excess data required by the use of inefficient methods of analysis.

Particular attention should be paid to selection of distributional models and, where applicable, of appropriate confidence bounds. The use of asymptotic distributions and central-limit-theorem results with small samples is common, and also is costly. One-sided confidence intervals are typically more appropriate and more efficient than the two-sided ones in general use.

Most of the studies examined by the author fail to incorporate in estimates all of the relevant data that appear in the text or in tables, because of the data are of more than one kind, or are from more than one source. Joint likelihood methods, weighted statistics, and the use of a Bayesian framework may permit the incorporation of all the available information.

In reports that the author has reviewed, it often has been possible to construct relatively simple analyses of the data with two to four times the efficiencies of those used in the original reports. In practical terms, this means that the statistical effort required for the improved data analysis is equivalent to doubling or quadrupling the volume of data. Commonly, a few hours of paperwork with a hand calculator produces the equivalent of several thousand dollars' worth of data, and/or several days of data-gathering.

MINERALOGY OF A "PROTOCONCRETION," GORDO  
FORMATION, LEE COUNTY, ALABAMA

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The physical properties, mineralogy, and iron oxide content of "protoconcretions" in the Gordo Formation were studied and compared to the sediment immediately surrounding them and to the overlying B-horizon.

"Protoconcretions" are generally circular to elliptical in outline and are redder in color than the surrounding sediment. Some "protoconcretions" are isolated from the B-horizon while others are connected to the B-horizon. The cohesiveness in a "protoconcretion" is greater than in the surrounding sediment. In overall shape, "protoconcretions" are generally cylindrical to bulbous.

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Soil samples analyzed by x-ray diffraction contain kaolinite, quartz, and hematite. Small flecks of mica were seen in each sample.

The predominant clay mineral indicated by x-ray diffraction in all samples is kaolinite. The greatest amounts of kaolinite occur in the B-horizon. The least amount of kaolinite is in the cross-bedded sediment. The "protoconcretion" contains an intermediate amount of kaolinite.

An iron analysis was done on all samples using x-ray spectroscopy. The B-horizon sample contains the most iron oxide with the cross-bedded sediment containing the least amount of iron oxide. The "protoconcretion" contains intermediate amounts of iron oxide.

"Protoconcretions" are extensions of the B-horizon and occur within cross-bedded sands in this particular case.

"Protoconcretions" differ from the true concretions by having no cementing minerals and by being bulbous and cylindrical in shape rather than spherical. It is suggested that these "protoconcretions" be thought of as authigenic pseudoconcretions.

### POTENTIAL ENVIRONMENTAL EFFECTS OF LIGNITE MINING IN THE ALABAMA-TOMBIGBEE RIVERS REGION

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There are an estimated 562 million short tons of near-surface lignite in the Alabama-Tombigbee Rivers Region of southwest Alabama. These deposits occur in the Oak Hill Member of the Naheola Formation (Midway Group) and the upper unnamed member of the Tuscahoma Sand (Wilcox Group). The Oak Hill lignite generally has a good heating value but its sulfur content is high. The Tuscahoma lignite is generally inferior to the Oak Hill lignite in heating value but has a lower sulfur content. Both of these near-surface lignites can be extracted using existing surface mining technology.

The detrimental environmental effects of coal mining in the eastern U.S. are well documented. The short- and long-term environmental effects of lignite mining in the Alabama-Tombigbee Rivers Region of southwest Alabama are not known at this time. These effects will depend on the nature of the overburden, topography, plant cover, methods of extraction, time of recovery and reclamation procedures. The potential effects, however, can be inferred from what is known about strip mining in other areas. Extraction of the lignites in southwestern Alabama will necessitate disturbance of the land surface and may create problems of acid mine drainage, increased erosion and sedimentation, and contamination of ground water. Preliminary data indicate that the primary environmental problems of mining in the area may be the low pH and unconsolidated nature of the overburden and the high sulfur content of the lignite. These factors could contribute to significant erosion and acid

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mine drainage unless carefully planned reclamation procedures are practiced.

### A PETROGRAPHIC STUDY OF THE AUGEN GNEISS IN SOUTHWESTERN LEE COUNTY, ALABAMA

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A common rock type in the Auburn area of Lee County, is locally referred to as augen gneiss. Large, well-exposed outcrops occur along several streams near the Piedmont-Coastal Plain boundary. It is typically dark colored with lighter bands and "eye-shaped" porphyroblasts set in a finer-grained matrix. In an effort to better define this prominent rock type, samples were collected across strike from several good outcrops exposed along Choctawhatchee Creek.

Petrographic studies indicate that the unit has been subjected to intense cataclastic deformation. Using the classification system of Higgins, 1971, the rocks found in the study area can be categorized as mylonite gneisses and porphyroclastic blastomylonites. Mineralogically, the rocks consist primarily of quartz, feldspar, biotite, and muscovite. However, the overall appearance of the various types present are related more to differing intensities of shearing than to differences in mineralogy.

Textural relationships suggest that the rock was originally a porphyroblastic gneiss which underwent cataclastic deformation accompanied or closely followed by some recrystallization. According to a preliminary map by Bentley and Neathery, 1970, the study area is located within the Towaliga Fault Zone, whose formation is probably responsible for the cataclastic texture which characterizes this augen gneiss.

### THE CORRELATIONS AND SIGNIFICANCE OF SOME SOLUTION, STRUCTURAL AND WEATHERING FEATURES IN NORTHWEST ALABAMA

Paul Moser  
Alabama Geological Survey

The orientation of sinkholes, joints, lineaments, streams, escarpment faces and cave chambers in a karst area of northwest Alabama indicate a striking mutually-related alignment which is probably controlled by correlated geologic processes. The dominant trend of five of these features is generally in a northwest direction. However, a secondary trend in a northeast direction characterizes cave chamber alignment.

The first five correlative and parallel surface features were probably acted upon contemporaneous geologic processes. Cave chamber alignment was possibly the result of an additional subsurface erosional action when surface water base level and water table were much higher.

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### COCCOLITHS OF MOBILE BAY: A PRELIMINARY REPORT

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The purpose of this study is to determine the presence of coccoliths in sediment samples taken in Mobile Bay and to identify taxa present and determine their areal distribution.

The Mobile Bay depositional province is a relatively narrow lagoonal environment located on the Southern Pine Hills of the Gulf Coastal Plain. Examination of sediment samples taken in Mobile Bay, using polarized light microscopy, revealed no coccolith taxa preserved, with the exception of samples taken near the entrance to Mobile Bay from the Gulf of Mexico. This is not to say that coccolithophorids are not present in the water column, but that coccoliths are not being preserved in the sediments. In Scholle and Kling's work (1972) titled, *Southern British Honduras: Lagoonal Coccolith Ooze*, the hydrological and geological parameters are similar to those in Mobile Bay, and the samples observed contained abundant coccoliths; this is interesting due to the absence of coccoliths in the Mobile Bay sediment samples.

Thus far, in this continuing study, it is possible to extend several hypotheses for the absence of coccoliths in the sediments of Mobile Bay: 1) The ratio of sediments to coccoliths is so high there appears to be an absence of coccoliths, 2) Pollutants in the Bay have a toxic effect on coccolithophorids, 3) Sediments in the Bay are highly rich in organic material and on decomposition could produce acidic conditions in the sediments preventing any coccolith preservation.

### CHUNNENUGEE: FOSSIL RIDGE REDISCOVERED

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The word Chunnenugee is an Indian word meaning "high long ridge" or "high bluff." Chunnenugee Ridge, or "The Ridge," as local townspeople call it, is located near the town of Union Springs in Bullock County, Alabama. Being the highest land in Bullock County, Chunnenugee Ridge attracted early settlers as an excellent building site for their homes.

Chunnenugee Ridge is described in newspaper articles, *National Geographic Magazine*, and professional reports as an area of early scientific interest.

Renamed the Enon cuesta and included as one of the Chunnenugee Hills, Chunnenugee Ridge is part of the Upper Cretaceous deposits of Alabama and lies within the eastern Gulf Coastal Plain. Fossils from the ridge are from the two great faunal zones known throughout the

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Atlantic and Gulf Coastal Plains as the *Exogyra ponderosa* zone below and the *Exogyra costata* zone above.

This paper describes the rediscovery, for geological study, of a fossiliferous railroad cut across the Enon cuesta scarp half a mile north of Peachburg, Bullock County, Alabama. It attempts to substantiate the occurrence of fossil arthropods, insects, in the strata of Chunnenugee Ridge. This writer has written two letters to Canada in an attempt to find the collection from Chunnenugee Ridge which the late Dr. Peter Brannon, former Montgomery archivist, saw in Canada and said the collection contained fossil insects. This area seems to have been neglected by geologists since 1941, but my search for the fossil insects continues.

### PRELIMINARY WHOLE ROCK GEOCHEMISTRY OF THE MITCHELL DAM AMPHIBOLITE: CHILTON AND COOSA COUNTIES, ALABAMA

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The Mitchell Dam Amphibolite is a metabasite located near the southern terminus of the central Piedmont of Alabama. It is one of many similar but smaller amphibolitic bodies which occur within the Higgins Ferry Group (formerly Ashland-Wedowee). Metamorphism of the Mitchell Dam is believed to have been essentially isochemical; therefore geochemical analysis has been undertaken in order to determine the protolithology. Thirty-three samples were analyzed for major elements, and the results interpreted graphically, using methods described by Macdonald and Katsura (1964) and Miyashiro (1975). The Mitchell Dam Amphibolite has the composition of a tholeiitic basalt, associated with highly silicic layers, either igneous or sedimentary in origin; and was possibly formed within an island arc system. Additional work using trace element analysis must be done in order to confirm or modify this hypothesis.

### A GEOLOGIC GUIDE TO THE CAHABA RIVER--AN INTEGRATED UNDERGRADUATE RESEARCH EXPERIENCE

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The Cahaba River Project has been funded by the Venture Fund of The University of Alabama as an effort toward stimulation of undergraduate research and enhancement of student-faculty interaction in Geology and Geography. The project will provide an opportunity for research experiences which integrate formal classroom studies, field courses, library research, field work, report preparation, and publication of results. Specifically the project involves 23 undergraduate students, as research teams of 3 or 4, in the production of a guide-book to the



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geologic aspects of the Cahaba River and its major tributaries. Each team is responsible for geologic description of a reach of the stream (average length 48 km.). The team reports will consist of maps and description of structural geology, stratigraphy, geomorphology (river morphology, river processes, and slope studies), environmental geology (effects of urbanization and mining), and localities for mineral and fossil collecting.

In addition to use in the guide-book, information from this project will serve as a source for student papers at professional meetings, and be used as input to the U.S. Forest Service for their study concerning incorporation of the Cahaba River under the Wild and Scenic Rivers Act.

If evaluation indicates the project has been successful, similar projects will be initiated involving the Black Warrior, Coosa, and Tallapoosa Rivers.

### A STUDY OF THE ENVIRONMENTAL GEOLOGY AND HYDROGEOLOGY PERTAINING TO THE USE OF SEPTIC TANKS IN THE LAKE TUSCALOOSA AREA

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Lake Tuscaloosa, completed in 1969, was formed by the damming of the North River  $1\frac{1}{4}$  miles from its confluence with the Black Warrior River. The lake supplies water for the residential, commercial, and industrial demands of Tuscaloosa. It also provides recreation and is a place of increasing residential development.

Lake Tuscaloosa is located on the "Fall Line." The rock units exposed in the area consist of the Pottsville Formation of Pennsylvanian Age which is in places overlain unconformably by deposits of late Cretaceous to Holocene in age.

Presently there is no municipal sewage connection in the Lake area, and residential homes are using septic tanks; however, problems are arising due to improper placement.

The purpose of the study is to delineate geologic constraints for proper installation of septic tanks. Individual homesites should be tested for the following:

- 1) depth to bedrock or impermeable clay layer
- 2) depth to water table
- 3) percolation rates to determine if the effluent can move properly through the soil and to determine the size of the absorption field
- 4) determination of erosion potential of slopes

This study is underway to integrate the above parameters with the planning process to produce maps to show the most feasible areas for



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septic tank disposal systems and those areas where septic tanks should not be used.

### PETROLOGICAL AND GEOCHEMICAL RELATIONSHIPS IN THE HILLABEE CHLORITE SCHIST IN THE MILLERVILLE REGION, CLAY COUNTY, ALABAMA

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In the Hillabee Chlorite Schist around Millerville, Alabama, mafic and intermediate rocks occur. The mafic unit, which comprises most of the Hillabee, consists of three types based on texture: 1) fine grained massive greenstone, 2) phyllite, and 3) massive greenstone with gabbroic-like texture. In all three mafic rock types the mineral association is epidote, chlorite, actinolite, albite and relic pyroxenes in varying abundances. The mafic rocks are compositionally similar to basalts.

In hand specimen the intermediate rock has a gneissic texture with hornblende porphyroblasts. In thin section, the rock has a phyllitic texture, and the hornblendes appear to be relic igneous grains. The mineral association is relic hornblende, sericite, chlorite, epidote, albite, and quartz. Compositionally, the intermediate rocks are andesitic, with higher  $\text{SiO}_2$ ,  $\text{Na}_2\text{O}$ , and  $\text{K}_2\text{O}$  and lower  $\text{CaO}$ ,  $\text{MgO}$ , and total Fe than the mafic rocks.

Geochemical data indicate that the parent basalt was an island arc tholeiite. Also, the association of the parent basalt with andesite lends credence to this idea. A possible model for the tectonic setting of the Hillabee Chlorite Schist is an island arc system; the phyllites are interpreted to represent incompetent ash falls and the greenstones represent more competent lava flows.

### THE TECTONIC RELATIONSHIPS OF THE HILLABEE CHLORITE SCHIST TO THE ADJACENT ROCK UNITS IN SOUTHERN CLEBURNE COUNTY, ALABAMA

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In southern Cleburne County, the Talladega Group, the Hillabee Chlorite Schist, and the Poe Bridge Mountain Group are the major geologic units. The Hillabee Chlorite Schist is a layered mafic volcanoclastic sequence containing lower greenschist facies mineral assemblages. The Talladega Group also contains low grade metamorphic assemblages. Upper amphibolite facies mineral assemblages are found in the Poe Bridge Mountain Group. The Hillabee Chlorite Schist and the Talladega Group have undergone the same structural and metamorphic events and show a concordance of structures and interlayering stratigraphic relationships. The

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Poe Bridge Mountain Group has undergone similar structural and metamorphic events including a higher grade of dynamothermal metamorphism, and three or more later deformational events. The upper boundary of the Hillabee is the Hollins Line Fault, which emplaces high grade rocks against low grade rocks. This fault has been suggested as a major reverse fault of large magnitude, marked by terminating lithologies, discordant structures, and an abrupt metamorphic grade change. The proper understanding of the relationships of the Hillabee Chlorite Schist to the adjacent lithotectonic units is critical for a more complete interpretation of the geologic history of the Alabama Piedmont.

### LOW ALTITUDE MULTISPECTRAL IMAGERY AS AN AID FOR LITHOLOGIC MAPPING

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Analyses of multispectral photographs taken in vegetative regions indicate that rock types can be differentiated. Electromagnetic radiation is reflected to the remote sensor primarily from vegetative surfaces. Underlying lithologies are frequently the dominant factor controlling vegetative distribution.

Multispectral photographs were enhanced by using the color additive viewer and by photographing and printing as kodolith and panatomic-x positive prints and as bas-relief positive prints. Panatomic-x prints were economical, were easy to use, and showed as much, if not more, detail than other type enhancements.

Studies were conducted to show the correlation between tonal values of the multispectral images and ground truth data such as lithology and moisture percent. High correlation was noted for both the red and infrared bands. Photographs should always be viewed stereoscopically prior to constructing lithologic maps. Field work must also be an essential part of map construction.

Characteristic signatures were developed to delineate broad lithologic types. Lithologic predictions were made based on signatures and subsequent field checking of predictions ensued. Percent correlation between predictions and field mapping was high for alluvial deposits and for indurated sedimentary rocks. Sands and clays could be delineated but with less accuracy than the previous mentioned lithologic types. If this type analysis were conducted in a remote region with natural vegetation the percent correlations should increase.

Multispectral analyses for lithologic determinations appear to have possible applications. Efficiency decreases in urban areas and areas not naturally vegetated. This type analysis will prove beneficial if limited time is a factor and if areas to be mapped have limited accessibility.

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### TRACE ELEMENT ABUNDANCE OF CERTAIN ALABAMA COAL ASH

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In order to determine if different coal seams can be distinguished by their trace element contents, seventeen samples collected from the Mary Lee, Blue Creek, and Jagger seams in western Walker County were analyzed for the elements silver, gold, cadmium, cobalt, chromium, copper, manganese, nickel, strontium, and zinc. The samples used were mine ash samples collected and prepared according to A.S.T.M. standards. Triplicates of each coal sample were ashed, fused in lithium metaborate, dissolved in dilute nitric acid, and analyzed against salt standards with a Perkin-Elmer Model 303 Atomic Absorption Spectrophotometer.

Differences in trace element concentrations among coal seams were not large, although several significant variations were apparent. No strontium was detected in any of the Blue Creek samples, although strontium does occur in significant quantities in the Mary Lee and Jagger seams. Copper and nickel concentrations were higher in Jagger samples than in those of the other two seams. Economic concentrations of the trace elements analyzed were not found in any seam.

The trace elements detected in these ashes are presumed to be both inherent and adventitious. Differences among seams are due apparently to adventitious epigenetic processes, notably through the action of mineralized groundwater. Concentrations of all trace elements considered appear to be consistent with Goldschmidt's observations on the elemental geochemistry of coal ash.

### A PETROGRAPHIC AND PELEOENVIRONMENTAL STUDY OF THE JEMISON CHERT IN CHILTON COUNTY, ALABAMA

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The Jemison Chert is a massive siliceous sedimentary rock sequence included in the low rank metasedimentary rocks of the Talladega Slate Belt located in the southwestern part of the Alabama Piedmont. It is composed dominantly of microcrystalline alpha quartz.

Petrographic examination of rocks very near the contact of the Jemison Chert and the underlying Butting Ram Sandstone, along with detailed field evidence shows large amounts of quartz and felspar clasts which decrease in abundance in the Jemison Chert away from the contact.

The fossil assemblage of the Jemison Chert includes different genera of Brachiopods, Bryozoans, and possible scarce Radiolarians and oolites. This seems to suggest a normal marine environment of moderate depth,

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below wave base. The possible occurrence of oolites may be due to the transport of debris into this environment since they are very scarce.

### THE FACTORS INVOLVED IN THE DEVELOPMENT OF A SANITARY LANDFILL SITE IN A LIMESTONE AREA: WITH SPECIAL REFERENCE TO HUNTSVILLE, MADISON COUNTY, ALABAMA

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Sanitary landfills are an efficient method of disposing of solid municipal waste if precautions are taken. Limestone as a dense impermeable rock with solutinal openings causes extra problems in the development of a sanitary landfill over it. Lack of an impermeable barrier, either suitable clayey soil or a man-made liner, could cause leachate, which is a chemically concentrated fluid waste, to come into contact with the aquifer and destroy its potability. The site should be chosen after a detailed study of the parameters listed in this paper are made of alternate sites. Inherent problems at the site must be researched and resolved before the waste is disposed of at the site. Lack of research could cause an environmental catastrophe. The author suggests that an Environmental Impact Statement be required before permission to use the site is granted.

### FORESTRY, GEOGRAPHY, AND CONSERVATION

#### A REPORT ON THE TUSCALOOSA TORNADO OF SUNDAY, FEBRUARY 23, 1975

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On Sunday, February 23, 1975, at approximately 1:30 p.m. the microbarograph located at the geology and geography department of the University of Alabama recorded a low of 29.42 inches of mercury. Meanwhile, a severe tornado struck the city of Tuscaloosa, one of three reported in the immediate area. This destructive storm stayed on or near the ground from Moundville, Alabama to Holt, Alabama, a distance of 25 miles. The course of the storm followed an almost straight line on a bearing of North 45° East. The tornado passed through one of the city's heaviest commercial areas, as well as numerous residential neighborhoods.

As a field study for Geography 402 (Climatology) instructed by H. Don Hays, a group of six students mapped on a microscale the damages caused by the tornado from Taylorville to Holt. Each student inspected a two mile section of the storm's path and mapped the total extent of damage. City zoning maps with a scale of one inch to 500 feet were used as base maps.

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The study concluded that although the tornado followed a straight course it varied in width from 300 to 2600 feet. However, the path of intense destruction modulated from extremes of only 50 to 750 feet. It was also apparent that the tornado responded to contours, gravity and forward velocity. Uniform destruction did not always accompany the tornado's trajectory and in many cases structures apparently in the twister's median path were unaffected, whereas intense random damage occurred at various spots. This may have been the result of the contraction, expansion and direction of severe suction spots.

### MINIMUM REQUIREMENTS PARAMETERS FOR ESTIMATING THE ECONOMIC BASE OF SOUTHEASTERN SMSA'S

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In a development conscious South, the community economic base study is a document vital to both the understanding of current conditions and the evaluation of proposed economic impacts. One special result of a base study is the generation of values for the relevant economic multipliers.

While there are direct methods for determining the nature and magnitude of the local economic base and its multiplier values, the application of these techniques may be limited by constraints on data collection. An indirect method, the minimum requirements technique, as described by Uhlman and Dacey, uses readily available industrial employment data as the means for establishing a surrogate measure estimate of the local economic base.

An examination of the employment profiles and populations of the Standard Metropolitan Statistical Areas (SMSA's), as defined in 1970, of nine southeastern states produces the parameters for linear functions required in each of fifteen industrial sectors to satisfy local demand for the goods or services of that industry. Employment levels in excess of that minimum requirement approximate the basic employment, subject to exogenous demand, of that industry. A summation of the linear functions of all industries produces the estimating equation

$$E = 61.42 + (0.000020) (P)$$

where E equals the estimated percentage of non-basic employment in an SMSA of population size P. The relationship

$$k_e = E/(100.0 - E)$$

will then provide an estimate of the employment multiplier  $k_e$ , as the number of non-basic workers required to support themselves and one basic worker.

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### EL PETEN, GUATEMALA: A DEVELOPING REGION

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El Peten, a sparsely-populated department in northern Guatemala, represents one-third of the total area of the country. The region has long been known for the production of chicle and mahogany lumber from its forest. Recent road construction has overcome the isolation of past centuries, resulting in a largely spontaneous immigration of settlers--more than 30,000 between 1964 and 1973. A government program provides for additional infrastructure, increases in beef cattle production, rational development and utilization of forest resources, and an increase in tourism. All this will result in expanding the role of the Peten in the economic development of Guatemala and in alleviating population pressure in other parts of the country.

### RODENT NUMBERS ON SITE PREPARED LANDS IN ALABAMA

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Arasan-endrin coated pine seed are recommended to repel birds and rodents for direct seeding to establish a stand of forest trees. The mixture is lethal to some birds and rodents.

Tests were made by the use of snap traps on the following areas: Lauderdale Wildlife Management Area, Thomas Wildlife Management Area, Bankhead National Forest, Choccolocco Wildlife Management Area, Wolf Creek Wildlife Management Area, Oakmulgee Wildlife Management Area, Butler Wildlife Management Area and in Bibb County.

Catches varied from .2 to 2.0 rodents per 100-trap nights. This is below the numbers that would justify the expense of treated seed.

### APPLICATION OF BERRY'S THEORY OF URBAN COMMERCIAL LOCATION TO TUSCALOOSA

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Since commercial establishments make up a large proportion of urban land use, it is essential for students of urban planning to understand some of the basic concepts and rationale underlying commercial location decisions. Therefore, it is the objective of this paper to explore the theoretical underpinnings of Berry's theory of urban commercial location and investigate its applicability to Tuscaloosa.



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Berry's work is based on the concepts of market geography and centrality. He developed the four following classifications of urban commercial location outside the central business district: (1) a hierarchy of business centers, (2) highway oriented commercial ribbons, (3) urban arterial commercial developments, and (4) specialized functional areas. The commercial establishments in Tuscaloosa were found to be typical of these classifications.

### THE STATUS OF GEOGRAPHY IN ALABAMA'S INSTITUTIONS OF HIGHER EDUCATION

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The purpose of this presentation is to determine the current status of geography in Alabama's public and private institutions of higher learning, so that plans can be formulated to promote the growth of the discipline in the future.

A questionnaire was used to gather data on geography programs, courses, enrollments, and instructors. Of the forty-six institutions contacted, nineteen responded. Analysis of the data received indicates that the bulk of Alabama's geography enrollment is generated on four campuses. A second finding is that approximately forty percent of the geography teachers in institutions of higher learning do not hold graduate degrees in geography.

It is suggested that greater dialogue be established between university and junior college geographers which will serve to stimulate interest on junior college campuses and ultimately lead to an increased flow of transfer students into geography programs at the universities.

It is further suggested that professional geographers encourage the State Board of Education to require geography in the curricula of junior and senior high schools throughout the state.

### THE GEOGRAPHY OF DEATH: A CULTURAL LANDSCAPE APPROACH

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Burial of the dead is a universal cultural trait; cemeteries, therefore, are one of the most numerous of all landscape features. Because of man's reluctance to disturb them, graveyards tend to be among the most persistent of man's impression upon the land. Cemeteries have only recently become the object of scholarly examination. They are storehouses of cultural data available to many disciplines. Religious, economic, and social factors are nicely exemplified and, because they are



relatively undisturbed, cemeteries are excellent for the analysis of folk traditions and their evolution.

The morphological method, initially used by Carl Sauer, provides a meaningful approach to the problem of cemetery classification. Observation over a decade has led to the conclusion that there are noticeable distinctions between American graveyards and a typology is needed. The morphology of a cemetery, by virtue of its inclusiveness, comes closest to achieving a total analysis. Selecting single traits, such as tombstone style, does not result in significant enough results to aid in graveyard classification.

It is proposed that the Upland South cemetery, from Texas to the Atlantic, possesses enough characteristic traits to recognize it as a unique type. Characterized by the lack of vegetation, few tombstones, and peculiar decorative techniques, perhaps the classification of American cemeteries might begin with the Upland South graveyard.

### THE GEOGRAPHY AND POLITICS OF MINING THE OCEAN'S FLOOR

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The increasing demand for minerals by industry and the increasing difficulty in obtaining these minerals on the land has encouraged large corporations and national governments to look to the ocean for new resources. The main resource of interest is manganese nodules, which contain nickel, copper, and cobalt, as well as manganese. The most important concern of prospective miners involves licensing, regulations and legal requirements in an area that has no international legal status. The developed nations hope that the exploitation of the ocean floor will lead to mineral independence for their industrial needs. However, the developing countries have complained that the resources on the floor of the open sea are the "common heritage of mankind."

The manganese oxides are found in grains, nodules, slabs, coating-on-rocks, and impregnations of porous material. A field of nodules 500 miles south of the Hawaiian Islands has been determined the best site for mining. Two mining systems; the continuous line bucket (CLB) and a hydraulic recovery method, which has been successful in tests by the Summa corporation's ship, the *Glomar Explorer*, provide means of recovering the valuable nodules.

The United Nation's Third Conference on the Law of the Sea is developing an ocean convention that would assure the equitable distribution of benefits gained from deep-sea mining. Prospects for success at an early date are not very promising. Unilateral action may proceed before an international agreement is found.

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### EVALUATION OF COMMUNITY DEVELOPMENT BLOCK GRANT FORMULA FOR CENTRAL CITIES

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This study evaluates the success of the allocation formula in the Housing and Community Development Act of 1974. The formula is supposed to distribute funds to the cities in greatest need. As stated in the Housing and Community Development Act, three variables define need: number of people living in central cities, number of people in central cities living under the poverty level, and number of houses in central cities with 1.01 or more persons per room. Poverty variable is counted twice.

Analysis of the data in this study shows that a close association exists between funding and the indicators of need. Two other statements, however, modify this conclusion. (1) Despite the strong association between funding and the indicators, certain central cities deviate from the expected allocation; and (2) no significant relationships occur between formula funding and measures of relative poverty and relative housing blight.

The effect of these conclusions is to increase the predominance of population in allocating funds. To reduce the influence of population, it is recommended that relative indicators of poverty and housing blight be incorporated into the formula process. The best variables of relative poverty and poor housing conditions are percentage of persons living under poverty and percentage of houses lacking some or all plumbing facilities. Once such changes evolve, the formula will come closer to achieving its purpose--allocation of funds to improve the living environment for people of low and moderate incomes.

### AN ECOLOGIC SYSTEM OF NORTHWESTERN YUCATAN

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The northwest coast of the Yucatan Peninsula represents an extraordinary example of an ecosystem involving vegetation, the hydrologic cycle, and human activity. A diurnal sea breeze serves as the driving force in the system of minimizing rainfall, particularly in the summer, and causing excessive rates of evaporation.

Human and vegetational responses to this semi-arid climate are seasonally oriented in two distinct regions: 1) a mainland limestone platform of "tree islands," and 2) a beach ridge complex. The tree islands consist of shallow cenotes, either filled-in or open, that are fed by groundwater from inland rains and are surrounded by a small, and

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occasionally lumbered, tropical hardwood forest. Salt collects in shallow basins between the beach ridges and serves as a major industry for the few coastal settlements.

### SEX DIFFERENCES IN TOPOGRAPHIC MAP READING ABILITY AMONG COLLEGE STUDENTS IN AN INTRODUCTORY PHYSICAL GEOGRAPHY COURSE

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Is it reasonable to expect sex differences in learning at the college level? The objective of this study was to determine if college males scored higher than college females on topographic map reading skills. It was found that there was no significant (.05) difference between males and females on the posttest after means were adjusted for differences on the ACT Composite scores and when the posttest was administered immediately after the instructional period. However, as evidenced by the delayed-posttest scores, it was found that males scored significantly (.05) higher than females on the delayed-posttest nine weeks later.

Why did males perform significantly (.05) better than females on the delayed-posttest? The writer offered several explanations. Since members of each sex are encouraged to become interested in the kinds of tasks that are most relevant to the roles that society expects of them in the future, differences in leisure-time activities between sample males and sample females may have contributed to higher scores on the delayed-posttest. Thus, higher male scores on the delayed-posttest may reflect general map reading skills built up over a longer period of time; past experiences by males influenced by cultural expectations; and formal classroom instruction and practice work.

Sample females' interests and hobbies were generally not oriented towards using topographic maps. Most females' ability to read topographic maps probably reflected first-time learning gained from formal classroom instruction and practice work. During the nine weeks interim period between the posttest and the delayed-posttest, some of the fundamental topographic map skills may have weakened more for the females than for the males.

### THE COMIC STRIPS: WHAT WOULD THEY DO WITHOUT GEOGRAPHY?

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The comics, an American tradition, draw heavily on geography as setting or inspiration for many of their episodes. A survey of selected

strips and cartoons revealed adventures and incidents circling the globe, touching five continents, and blanketing North America. Systematic topics geographers take for granted became pivotal factors determining the outcome of various undertakings. Not only geography but history, geology, weather and climate, politics, philosophy, sex, sociology, literature, and current events as well are cleverly incorporated for the reader's enjoyment and enlightenment. The thesis prompting the survey is the conviction based on observation and sampling that relatively few Americans of any age read the comics with any degree of regularity. Further, classroom experience questions the capability of many readers to understand and appreciate the satire and sophisticated play on words presented daily. A chronic criticism of modern education in recent years has been the complaint that "Johnny can't read." Johnny cannot, or will not, yet read as much and as often as he should. The comics, thanks to very well-informed creators, reveal more insight into social mores interacting with natural or geographic conditions showing people and places and events as they are than much of the trivia offered readers today. The conclusion drawn is that the comics enjoyed as a daily habit might become the vehicle for renewed interest in all facets of knowledge, especially geography, pertaining to life and society in the world we live in.

## PHYSICS AND MATHEMATICS

### CROSS SECTIONS FOR $^{45}\text{Sc}(n,2n)^{44\text{m}}\text{gSc}$ AND $^{93}\text{Nb}(n,2n)^{92\text{m}}\text{Nb}$ IN THE ENERGY RANGE 13-19 MEV

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Activation analysis has been used to experimentally measure the excitation functions of  $^{45}\text{Sc}(n,2n)^{44\text{m}}\text{gSc}$  and  $^{93}\text{Nb}(n,2n)^{92\text{m}}\text{Nb}$  in the neutron energy range 13-19 MeV. The neutrons were produced by the  $\text{T}(d,n)^4\text{He}$  reaction with the Auburn University 3 MV accelerator and placing the samples from 0-140°. Absolute cross sections are calculated by applying the mixed powder method with  $^{27}\text{Al}(n,\alpha)^{24}\text{Na}$  as the monitor reaction. The experimental isomeric yield ratios were calculated by analyzing the activity of each reaction and then applying a least squares fit to the data.

### TOTAL CROSS SECTIONS FOR THE $^6\text{Li}(d,n)^7\text{Be}$ REACTION

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The  $^6\text{Li}(d,n)^7\text{Be}$  reaction has been studied at bombarding energies of 1.0 and 2.0 MeV. Total cross sections, believed to be accurate to 25%, have been determined from the yield of the  $^7\text{Li}^* 477\text{-keV } \gamma$  ray.

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Preliminary data indicates average values of 84 mb at 1.0 MeV and 96 mb at 2.0 MeV.

### AN INEXPENSIVE NMR GAUSSMETER

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A NMR gaussmeter is described. With 3 interchangeable probes, the device has a frequency range from 7 to 28 MHz, which corresponds to magnetic field intensities of 1.6 to 6.5 k-gauss. Limitations and applications to charged particle momentum analysis are also discussed. The entire device can be easily built for less than \$20.

### DEVELOPMENT OF COMPUTER ASSISTED INSTRUCTION FOR CALCULUS LEVEL GENERAL PHYSICS AT A SMALL COLLEGE

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Computer assisted instruction (CAI) has been developed during this school year for the sophomore general physics course at Tuskegee Institute. The development of teacher written CAI came as a result of attempting to individualize instruction for marginally prepared college students using only existing facilities, a Hewlette-Packard 2000 Access System operating in the BASIC language. A number of commercial programs proved to be unsuccessful because of language or content.

The programs developed at Tuskegee use chaining to other programs, automatic scoring, recording, and log off. The student has only to log on, give his name, and select the topic. The student does not need the ability to type or program and needs only to know how to log in and respond to questions. A calculator and paper are generally required to work each lesson. The computer obtains the proper program and logs the student off when finished. The person taking the lesson cannot break execution or modify any portion of any program.

The CAI uses a standard starting program (START) which contains the logic. New programs may be written by the instructor with only a minimum of difficulty and programming ability. By using CAI, the amount of time spent answering student questions on how to work problems has been greatly reduced. Consequently, more time can be spent in teaching physics. Student response and rapport has been quite high.

ELECTRIC FIELD EFFECT IN THIN BISMUTH FILMS

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Electric field effect measurements were used to search for quantum size effects in bismuth films, ranging in thickness from 30 nm to 120 nm. The films were produced by vacuum evaporation onto mica substrates which were at 215 C. Silver counter electrodes were deposited on the other side of the mica.

The electric field effect measurements determined the resistance of the bismuth films as a function of the electric charge applied to the capacitor, which was formed by the bismuth film and backing electrode. The quantity  $1/R(\Delta R/\Delta Q)_{Q=0}$  was observed to oscillate as a function of film thickness ( $R$  = film resistance,  $Q$  = added charge).

LUMINESCENCE IN NON-REACTIVE MOLECULAR SYSTEMS INDUCED BY A  
VIBRATIONAL EXCITATION OF A NORMAL MODE THROUGH THE  
MULTIPLE IR PHOTON ABSORPTION PROCESS

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In the process of internal conversion and intersystem crossing, vibrational excitation energy imparted to a molecule by the multiple photon absorption may be distributed among the electronic states of the same molecule. This process, the vibrational to electronic (V-E) energy transfer, is explainable in general terms by the non-applicability of the adiabatic (Born-Oppenheimer) approximation for the high vibrationally excited states. Typically, a molecular electronic state is characterized by energy eigenvalues exceeding a few eV above the ground electronic state. The lowest vibrational states are typically separated by 0.05 to 0.1 eV energies. Hence, if the molecular system is vibrationally excited by the absorption of energy from a weak electromagnetic field, the ratio of electronic to vibrational eigenvalues is much greater than 10 and therefore the intersystem coupling does not take place. With the availability of pulsed intense IR lasers, however, the vibrational system of a molecule can be excited to a high vibrational state whose energy eigenvalue may be of the same order of magnitude as the lowest-lying excited electronic state. When this occurs, there is a finite probability of intersystem crossing that creates an excited electronic state. Subsequently, there is another finite probability that the excited electronic state will decay through an electric-dipole allowed transition to its ground state and emit a photon of an energy much greater than that of the incident radiation field. This effect is known as the IR laser induced luminescence (LIL) and is easily observed in relatively isolated molecules. It has been speculated that the emission of visible



luminescence observed in laser induced chemistry<sup>(1)</sup> may be due to this effect. The first-principle theoretical treatment of the IR LIL effect is rather difficult because of the non-separability of vibrational and electronic eigenfunctions; hence, the usual methods of quantum theory which are based on the validity of the Born-Oppenheimer approximation cannot be directly applied in predicting various intersystem crossing probabilities. Furthermore, beside the radiative decay channels, there are also many non-radiative decay channels which lower the efficiency of the IR laser energy conversion into the visible. However, the photon energy of LIL is typically in the visible-uv spectral range in which sensitive photo-effect detectors are readily available. Therefore beside the demonstration of an interesting physical effect, the IR LIL process may be used to identify remotely molecules of interest in air pollution, and remote schemes for detection of materials and targets of opportunity. As a first step to predict analytically the probability in V-E energy transfer, we have evaluated IR laser intensities and pulse durations needed to attain a certain distribution of vibrational states by a nearly resonant excitation of a fundamental vibrational mode in multiple-photon process.<sup>(2)</sup> The molecular system was patterned by an anharmonic oscillator coupled to the radiation field by the electric dipole moment. Phenomenological damping parameters have been introduced to follow the decay of the initial vibrational occupation number distribution attained at the end of a short IR laser pulse. The time-evolution of the vibrationally excited state is described by the Liouville equation whose numerical solutions have been attained for arbitrary dipole moments, IR laser pulse durations, IR laser intensities and various relaxation times. These results are being applied to design the experiments in measuring IR-LIL conversion efficiencies to molecules of interest in the applications.

## References:

- (1) G. A. Tanton, H. C. Meyer, and R. I. Greenberg, Luminescence in Laser Photochemistry Experiments, Bull. SE APS, *43*, 17 (1976); see also Bull. APS *22*, 497 (1977).
- (2) L. M. Narducci, S. S. Mitra, R. A. Shatas, and C. A. Coulter, Selective Multiple Photon Absorption by an Anharmonic Molecule, manuscript in press with Phys. Rev. A.

## INFRARED LASER AUGMENTED CHEMISTRY OF BORANES: SINGLE STEP FORMATION OF CRYSTALLINE DECABORANE FROM DIBORANE BY THE VIBRATIONAL EXCITATION OF THE $\nu_{14}$ FUNDAMENTAL MODE\*

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Vibrational excitation enhanced, laser-induced-chemistry (LIC) experiments are reported that yield decaborane  $B_{10}H_{14}$  crystallites from the gas phase diborane  $B_2H_6$  at room temperature. Without the laser irradiation,  $B_2H_6$  is relatively stable, and the dark reaction rate is negligible



compared with that attained under illumination. In a similar experiment described previously, Bachman, Kompa et al<sup>(1)</sup> obtained predominantly a *closo*-borane, icosaborane, [B<sub>20</sub>H<sub>16</sub>] upon irradiation with a CW CO<sub>2</sub> laser of a reaction vessel filled with diborane. In our experiments, we varied the reaction cell pressure and the laser intensity to maximize the yield of a *nido*-borane, B<sub>10</sub>H<sub>14</sub>, as the predominant solid compound produced by the LIC. The reagent gas, B<sub>2</sub>H<sub>6</sub>, was prepared by at least quadruple bulb to bulb distillation of B<sub>2</sub>H<sub>6</sub> drawn into an all-glass manifold from a pressurized steel container of B<sub>2</sub>H<sub>6</sub>. The reaction cell fitted with IR transmitting windows was evacuated with  $\Delta$ N<sub>2</sub>-trapped diffusion pump and filled with B<sub>2</sub>H<sub>6</sub> to the desired pressure monitored by a mercury manometer. Laser irradiation was undertaken with grating-tunable CW CO<sub>2</sub> laser (Coherent Radiation Model #42) tuned to the absorption peak of the  $\nu_{14}$  fundamental vibrational mode of diborane. Laser power, intensity and reactant gas pressure were varied to maximize the yield of decaborane. Infrared spectroscopy was employed to determine the LIC reaction products; decaborane was sublimed from the reaction vessel walls into a weighed vial and identified by its infrared spectrum and melting point. The gross reaction  $5(B_2H_6) + nh\nu_{14} \rightarrow [B_{10}H_{14}] + 8(H_2)$  was optimized to give yields up to 15% at diborane pressures of 50 to 450 Torr and laser intensities between 10-20 W cm<sup>-2</sup>. Typically, approximately 10<sup>4</sup> CO<sub>2</sub> laser photons were expended in obtaining one molecule of B<sub>10</sub>H<sub>14</sub>. Since the formation of pentaborane appears to precede the growth of B<sub>10</sub>H<sub>14</sub> crystallites, the actual LIC reaction path is seemingly much more complicated than indicated by the gross reaction. Tentatively, the relatively high number of photons required to obtain one molecule of reaction product is explained by the vibrational deactivation and by the heat conduction to the walls of the reaction vessel mediated by the free hydrogen released in the reaction. Also, contrary to the Reference (1), no luminescence was observed during the irradiation.

## Reference:

- (1) H. R. Bachman, H. Nöth, R. Rinck, and K. L. Kompa, Chem. Phys. Lett. 29, 627 (1974).

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## COMPARISON OF PROPAGATION OF SUBMILLIMETER AND INFRARED WAVELENGTHS THROUGH FOG

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Fog is one of the major obstacles to infrared and submillimeter wave propagation in the atmosphere. Unfortunately, observational programs relating electro-optical propagation parameters to fog characteristics have not been made systematically.

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Visibility is routinely measured but propagation through fog depends upon liquid water content and drop-size distribution which are not available as standard meteorological observations. The data are limited even when presently available measurements throughout the world are considered. Therefore, each available set of measurements was classified according to the type of fog which was probably represented. This classification was used to determine propagation characteristics of different submillimeter and infrared wavelengths for the different types of fog.

### MICROWAVE TRANSMISSIONS STUDIES OF A PULSED HELIUM DISCHARGE

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Microwave techniques<sup>1-3</sup> provide a reliable means of obtaining the time evolution of the electron number density in a transient plasma. Transmission--reflection experiments and microwave interferometry are discussed, as well as preliminary transmission--reflection results for a pulsed plasma.

1. M. Heald and C. Wharton, *Plasma Diagnostics with Microwaves* (John Wiley and Sons Inc., New York, 1965).

2. R. Huddlestone and S. Leonard, *Plasma Diagnostic Techniques* (Academic Press, New York, 1965), p. 477.

3. S. Glasstone and R. Lovberg, *Controlled Thermonuclear Reactions* (D. Van Nostrand, New York, 1960), p. 170.

### A COMPARISON OF SPECTROSCOPIC OBSERVATION OF TWO VACUUM SPARK PLASMAS

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The spectra from two vacuum spark discharges in the 300 to 500 nm range are compared. The absorption spectrum obtained in one case is contrasted to the emission spectrum obtained in the other case. Differing magnetic field configuration is cited as a possible cause for the spectra observed.

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### TIME-RESOLVED MAGNETIC FIELD MEASUREMENT IN A HIGH-TEMPERATURE, DENSE VACUUM SPARK

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Detailed magnetic field measurements inside the vacuum spark discharge were correlated to the current passing through the discharge. It was observed that the magnetic field remained positive throughout the discharge whereas the current performed simple RLC oscillation.

In order to explain this phenomena it was assumed that the difference between the magnetic field measured and the calculated magnetic field due to the current was a result of a displacement current within the discharge chamber.

Calculations showed the displacement current to decrease linearly with time until the end of the first half-cycle when it begins to decay exponentially. The hypothesis is advanced that the displacement current is due to a non-neutral electron-dominated plasma in the chamber.

### SOLUTIONS OF THE GENERALIZED FELLER EQUATION

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The one-dimensional, autonomous, parabolic equation

$$A(x)z_{xx} + B(x)z_x + C(x)z - z_t = 0, \quad z = z(x,t), \quad (1a)$$

with coefficients

$$\left. \begin{aligned} A(x) &= \alpha x^{\lambda+1}, \quad \alpha > 0, \lambda < 1, \\ B(x) &= \beta_1 x^\lambda + \beta_2 x, \quad \beta_{1,2} \text{ real}, \\ C(x) &= \rho x^{\lambda-1} + \beta_2, \quad \rho = \lambda[\beta_1 - \alpha(1 + \lambda)] \end{aligned} \right\} \quad (1b)$$

will be considered on the domain  $x > 0, t > 0$ . Equation (1a,b) is of Fokker-Planck type. It is called the generalized Feller equation.

There exists a basic solution of (1a,b) and its adjoint which defines an integral kernel. The general initial condition solution of (1a,b) can be given in terms of an integral transform (singular integral) for any initial function which is summable over every compact interval. Furthermore, there exist singular solutions, conservative solutions, and delta function initial condition solutions.

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Let  $v = (1-\lambda)^{-1}(\alpha^{-1}\beta_1 - 1 - 2\lambda)$ . Then, if either  $\lambda < 0$ ,  $v = -\lambda(1-\lambda)^{-1}$  or  $\lambda = 0$ ,  $v < 0$ , there exist also boundary condition solutions which can be expressed as unilateral convolutions for any boundary function which is summable over every compact interval. In this case an initial condition can be imposed in addition to the boundary condition.

The basic distribution laws of Maxwell, Wien, and Poisson can be derived from equation (1a,b) for suitable values of the parameters.

## INDUSTRY AND ECONOMICS

### THE EQUITABLE SALARY PROGRAM OF THE UNITED METHODIST CHURCH: A MICROCOSM OF MODERN AMERICA

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The great majority of United Methodist Church parishes have fewer than 200 members. And most of these small churches are located in small towns or in the open country. Without outside assistance, they are unable to attract and hold pastors.

In this situation, each of the 70 regular conferences in the Church have established "equitable salary programs." These plans have as their objectives to assure a minimum standard of living for pastors, to promote equitable salaries for all pastors, and to enable the Bishops to assign ministers as needed to further the mission of the church.

In carrying out this salary subsidy program, the equitable salary commissions encounter numerous problems which confront society at large. These questions and issues constitute a microcosm of modern America.

For instance, the commissions must decide which pastors should receive aid, much as social workers must decide who receives public assistance. Ministerial couples reflect the rise of women's liberation. Pastors of retirement age are pressed out of the ministry much as older private workers are forced into retirement. Seniority affects minimums set in many conferences, just as in most factories. Many conferences, like welfare agencies, pay more to pastors living in areas with higher costs of living.

Overall, the plans have been successful in providing a minimum standard of living, but the funds attracted have not been sufficient enough to enable the Bishops to assign ministers as needed without regard to the ability of the local churches to pay. Nor have the programs significantly influenced salaries throughout the conferences so as to make them "equitable."

CONSIDERATIONS FOR EVALUATING THE SELECTION OF  
PARTICIPANTS AND THE EFFECTIVENESS  
OF A JOBS PROGRAM

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Unemployment of labor resources continues to be a problem of major importance in these United States. Several political schemes have been set forth and continue to be proposed by the Legislative and Executive branches of government. Labor Unions also have their schemes. Many of these jobs training programs have been ineffective in actually training and placing an underemployed person in a rewarding job market. The success and effectiveness of most jobs programs have been measured by the numbers who successfully complete the prescribed course of training. Costs per graduate remain high when measuring job program success in this way.

However, the success of most training programs can generally be measured more ways than simply whether a person graduates or not. For this reason the authors sought to seek out other short-run and long-run variables which would also measure the effectiveness of jobs training programs. The Job Corps Training Program near Nemo, South Dakota was selected as a focal point of study. Least squares regression was used as a tool in determining statistical significance of other job success measures.

Educational milestone, post Job Corps pay scale and length of stay were some of the dependent variables considered. Entry competence and other test scores were considered as independent variables for the regressions.

Among the findings, it was noted that the longer a corpsman stays in the training program the more likely he is to improve his vocational potential and his educational attainment. But more important, the longer the stay, the longer the individual is exposed to the socializing process of learning to accept responsibility and to get along with others. Also, it is crucial to note that success measured by the six point effectiveness scale is closely correlated with race. The black corpsman did significantly better than their white colleagues.

Implications of this study are important to center management, screening and processing procedures and to economic efficiency of Job Corps Centers. The importance of flexibility in center management cannot be overemphasized. That is, success can be achieved in several other ways than just trying to make each enrollee graduate. Some stay only six months and improve themselves economically.

CHANGING TYPES OF RURAL HOUSING IN THE TENNESSEE VALLEY

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The type of rural housing has changed in the past and will change in the future as families adjust to economic conditions, family resources, social pressures, availability of materials, and the knowledge available to deal with these.

Housing types used by major institutions and affluent urban families have been well documented in literature. But most knowledge of homes for rural families of moderate means has been incidental to other writings or in folk or oral history.

In recent years, some attention has been given to describing rural housing quality. This has been reported in government censuses and surveys and in literature of advocates for programs for the rural poor. Others have begun designing improved housing for the rural people of moderate means. These efforts have been led by a southern rural housing research team sponsored by the USDA land-grant university system and other agencies such as TVA.

Typical homes of the rural South in the past included, in succession:

1. The one- or two-room log cabin located on an open stream, oriented to be heated by the sun and using wood for cooking fuel until the late 1800's.
2. A three-room house of rough sawn lumber with an open dug well and a stove used for both space heating and cooking built during the late 1800's.
3. A several-room weatherboarded house of finished lumber featuring a hand water pump, a cook stove, and a fireplace for space heating, built in the early 1900's.
4. A smaller brick veneer house with indoor plumbing, electric water pump, and electric heat, constructed with specialized hired labor, built in the 1940's or 1950's.
5. And finally, a factory-built mobile home using considerable metals and other manufactured materials and loaded with many kinds of electric gadgets of convenience, built since circa 1960.

Several types of housing are being designed by the cooperating agencies for use by moderate-income rural families. Types of the future will be determined by changing energy and materials availability and costs. Some representative designs now being use-tested by occupying families to meet these needs are:

1. Typical exterior appearance and room arrangement with solar energy collectors integrated into a conventional roofline. The system may also include cooling using cool night air as a heat purge.

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2. A combination solar attic greenhouse collector and residence for farm families.
3. High heat insulation systems using traditional insulation materials.
4. High heat insulation systems using soil as an insulator and built largely underground. This can be combined with solar heat collectors, or with other heat sources.
5. Flexible housing produced by having external "pole-type" frame and movable curtain walls making changes in location of walls, doors, windows, etc., easy to accommodate changes in family desires and needs.

### PROFIT MANAGEMENT OF RETAIL LIME VENDORS

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The agricultural limestone business of four independent lime vendor firms in Alabama and Tennessee was analyzed in 1974 using a case study approach. These firms operate in a market structure that approximates monopolistic competition. The industry was characterized by excess capacity. Barriers to entry or exit of agricultural lime firms were low, very little product differentiation existed, and price competition was practiced extensively. The pricing policy of these independent vendors is to meet competition prices or sell below the price of the competitors. Frequently, the price was inadequate to cover full cost when depreciation on equipment was included.

None of the independent vendors kept adequate records for making management decisions. Rather, decisions were made based on what the manager thought or remembered about his costs. Sales of lime were obtained through "telephone orders" initiated by the purchaser. No advertising or promotion was done by the vendors.

Reasons vendors sometimes priced agricultural lime below their full costs were:

1. Since they kept inadequate records for documenting their full cost, they tended to underestimate the full cost of hauling and spreading a load of lime, particularly for sales that resulted in long hauls.
2. All vendors operated a "hand-to-mouth business." Cash flows were a problem for many, and they made sales to generate cash to meet monthly bills even though sales might be costly because of distance from lime supplies. Although this policy kept the firms in business in the short run, exit of firms is common and frequent if the primary business is agricultural lime retailing. None of the vendors made allowance for the purchase of new equipment in their records or in their pricing decisions.



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Income to labor was much less than minimum wage, and vendors often worked from 10 to 12 hours during the peak lime season.

Independent vendors did not take advantage of economies available to them such as field stockpiling and scheduling to maximize efficiency of driver time. Stockpiling of lime at the vendor's place of business was often avoided to minimize investment costs which increased hauling costs. It was common for the vendor to drive 50 miles round trip to spread 8 tons of lime. This distance included driving from his place of business to the lime quarry for a load of lime and then to the farmer's field and return. No sales effort, inadequate profit margins, inexperienced drivers, and older poorly maintained equipment resulted in poor service to farmer customers and low returns, often submarginal, to the retail agricultural lime vendors.

Cost savings could be realized by coordinating sales efforts so that lime can be stockpiled in or near customer fields so that spreader trucks are utilized in the field and their use for over-the-road hauls is minimized. Records should be established and maintained for use in making management decisions, including replacement of equipment, pricing to farmers, and opportunities for market development. Preventive maintenance of equipment should be practiced by vendors during off-seasons and during periods of adverse weather to minimize downtime during periods of peak spreading.

### PROJECTIONS OF IMPORT TONNAGES THROUGH THE PORT OF MOBILE, ALABAMA, 1980-2035

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The purposes of this paper are to present the import tonnages projected to move through the Port of Mobile, Alabama during the period 1980-2035, and to describe the methodology used to prepare these projections, which were developed as part of a larger study for the Corps of Engineers. A simple model was used to relate a nine-year moving average of import tonnages of each important commodity imported through the Port of Mobile to one or two appropriate independent variables and a time variable. The independent variables include gross product originating in appropriate end-use sectors, population, and per capita income at the national, regional, or tributary-area level in Alabama. Depending upon the trend of the nine-year moving average of import tonnages of a given commodity, an appropriate mathematical form was chosen for statistical estimation of the regression equation. The regression equations were estimated separately for 23 major commodities. The remaining tonnages were treated as a single commodity.

Total imports of all commodities from the Port of Mobile were 8.8 million tons in 1970 and are projected to increase to 13.165 million tons in 1980 and to 48.903 million tons in 2035. Among the 24 total projections, 8 are projected to decrease and the remainder are projected to increase.

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### TOWARD A MORE EFFECTIVE FRAMEWORK FOR ECONOMIC ANALYSIS

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The American economy is characterized by accomplishments and weaknesses in terms of the commonly recognized goals and objectives. These experienced results suggest reexamination of the framework and its use in economic analysis.

This paper has three major components. First, there is the recognition and orientation of the *natural order* concept in a more conspicuous role than is characteristic of contemporary works. Second, there is emphasis upon the *knowledge* element oriented in a *systems* perspective for decision making. This leads to the third element of *strategies* to further accomplish the desired goals and objectives. These strategies are offered conscious of the multi-variable dimensions of the economy.

### IMPORTANCE OF FERTILIZER USE IN MAINTAINING A FAVORABLE BALANCE OF TRADE

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The United States is the world's leading exporter of agricultural products. In 1974 and 1975 the Nation's agricultural exports were almost \$22 billion and accounted for one-sixth of the world's agricultural exports. Agricultural exports accounted for one-fourth of the total U.S. exports in 1974 and 21 percent in 1975. Imports of agricultural products such as coffee, sugar, bananas, etc., amounted to slightly less than \$10 billion in 1974-1975--10 percent of the value of all imports. Agriculture had a positive trade balance of almost \$12 billion which offset the nonagricultural trade balance of about \$10 billion to give a positive total trade balance of about \$2 billion in 1974 and 1975. The ability of U.S. agriculture to deliver an abundant supply of food and fiber for the Nation's consumers and maintain a comparative advantage in the world market can be attributed to the use of fertilizer and other modern technology. Estimates suggest that about 37 percent of all U.S. crop production can be attributed to proper fertilizer use.

Crops produced for export accounted for over one-fourth of the fertilizer used in the U.S. in 1974, and the share is projected to increase. In 1974 over one-half of the plant nutrients used to produce feed grains, soybeans, and wheat for export was applied in the north central region. Tobacco, soybeans, and cotton were produced for export

in the south Atlantic and south central regions and required significant quantities of fertilizer. Fertilizer use on crops for export was relatively insignificant in the north Atlantic, mountain, and Pacific states.

World demand for agricultural products is expected to increase. If this demand is supplied by U.S. producers, the demand for fertilizer will increase, since most productive agricultural land has already been brought into production. Fertilizer will play a major role in the ability of U.S. farmers to maintain a competitive edge in the world market and contribute significantly to a positive U.S. trade balance.

### AN OVERVIEW OF ALTERNATIVE RATE STRUCTURES

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The question of rate design has become a primary issue in the analysis of the conduct of the electric power industry. Those who advocate departure from present practices and policies do so in response to rapid changes in the economic and social environment of the utility industry. Alternative rate design proposals include time-of-use, inverted, life-line, and a variety of other rate forms.

In response to these alternative rate reform proposals, the utility industry, its regulators, and the Federal Government have embarked on a number of rate test and demonstration programs. In addition, several states have implemented various alternative rate designs for some or all classes of consumers.

The principal issues of rate reform involve reduced costs through improved capacity utilization, energy conservation, reduced environmental impacts, improved energy resource allocation, improved financial stability for the utility, and improved welfare for the economically disadvantaged. Each of these objectives is associated with one or more of the rate alternatives under discussion. Careful analysis of the objectives of rate reform indicates the complex nature of rate design when objectives are conflicting or even mutually exclusive.

This paper summarizes the major factors contributing to the concern over electric rates, develops the principal cost issues which form the foundation for time-differentiated rates, and analyzes a variety of cost and noncost rate structure alternatives. Finally, the paper summarizes both action and reaction of regulators and industry spokesmen to the rate issues.

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### SCIENCE EDUCATION

#### ENVIRONMENTAL RADIOACTIVITY MONITORING OF SAMPLES TAKEN FROM THE AREAS SURROUNDING THE TVA NUCLEAR POWER PLANTS

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A summer research project was conducted at the TVA Radionanalytical Laboratory to improve analytical procedures for  $^{131}\text{I}$  in milk. Techniques were developed to shorten the time necessary for chemical separation of iodine from milk. Beta-gamma coincidence counting techniques were developed as an alternative to low background beta counting. A lower limit of detection of 0.016 pCi/l was achieved while substantially reducing the amount of time and effort necessary to carry out the analytical procedure.

#### AGRICULTURAL EDUCATION FOR COMING GENERATIONS

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The steadily increasing efficiency of the American farmer has been noted widely. With less than five percent of our population engaged in farming, food and fiber producers have become a minority group. But this relatively small segment produces adequately for our needs plus large quantities for export--and provides more than one-third of the jobs in the labor force. This is cause for considerable satisfaction.

At the same time, the minority position of agriculture also is cause for concern. The portion of the population with a working knowledge of agriculture and its problems is decreasing. This could portend trouble down the road for those concerned with generating public support for agriculture, particularly among policymakers.

General courses of study, books, and resource materials contain only limited information on agriculture and this is used by a small percentage of today's students. Agricultural courses offered in our schools reach less than five percent of the students. About 5,000 students are graduated from Alabama high schools each year with some training in agribusiness--about one-third of the number needed for career replacements. Guidance counselors indicate a serious deficit in agricultural career opportunity material.

Several programs underway are altering present trends and, with proper support, could become very effective. Additional awareness of the situation is needed within the present educational structure.

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Similarly, awareness among groups outside the school system could enhance ongoing programs and lead to additional innovations with far-reaching effects.

TVA is helping to develop several activities which will strengthen agricultural awareness and education in the public school system. Among these are: (1) a summer conference on resource development, (2) helping to organize and promote student visits to operating farms, (3) preparation of supplementary curriculum materials, and (4) involving high schools in experimental testing of new fertilizers.

### OCEANOLOGY FOR THE LAND-LOCKED: AN ELEMENTARY SCHOOL SCIENCE APPROACH

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and  
Ernest D. Riggsby  
Columbus College

This is an interim report of an effort to design a unit of study in oceanology for fifth and sixth grade students who will not have access to the "real ocean" during the study. Certain of the students who work with this unit never have taken a trip to the seashore nor have had any direct experience with a large body of salt-water. From a collection of coral shells, preserved specimens, a small salt-water aquarium and a representative assembly of experiments, demonstrations, investigations, and activities, the students are guided in their exploration of the science of oceanology. A wide array of home-made and commercially prepared audiovisual aids are utilized. The unit is designed for approximately six weeks of study, with forty minutes of class time, five days per week. Selected topics include: (1) physics--tides, waves, currents, storms, temperature, pressure, and turbidity; (2) chemistry--components of sea-water, corrosion, salinity, and dissolved gases; (3) biology--life in the epicontinental seas, and life in the abysses; and (4) notions about the ocean--a *potpourri* of fact, fable, and *futures*.

### MICROTEACHING ESS UNITS IN SPECIAL EDUCATION CLASSES

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Students in my Elementary Science Methods course have been teaching small groups of children for several years. Some time ago we started teaching the ESS units "Kitchen Physics," "Batteries and Bulbs," "Light and Shadows," "Pattern Blocks," "Structures," "Tangrams," "Behavior of Mealworms" and a few others to primary and intermediate EMR classes.

The students and the Special Education teachers were generally pleased with the response of the students to these hands on activities.

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Since none of these units require reading, many of the EMR students appeared to handle the material quite as well as average classes.

### USING CLASS MEETINGS TO DEVELOP SCIENTIFIC THINKING

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and  
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Teaching scientific thinking in the public schools is a different and often hap-hazard process. Much has been written in support of using an inquiry or discovery approach to the teaching and learning of science concepts and scientific thinking. The primary purpose of this study was to investigate the use of group process in stimulating and developing scientific thinking among students--in this instance, among thirty-two third grade students in a self-contained classroom.

A model for group process called "class meetings" was used to involve students not only in thinking processes such as observing, classifying, inferring, theorizing etc., but also in skills of group interaction such as listening, questioning, responding and cooperation.

Observations by the classroom teacher indicate that students generally showed improvement in both thinking and communication skills. Further investigation in this area is planned at both elementary and secondary levels.

See Dr. William Glasser's book *Schools Without Failure* for a description of the "class meeting" technique and discussion of its rationale.

## SOCIAL SCIENCES

### THE CAREER OF THE IRONCLAD *TENNESSEE* (1862-67)

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The ironclad *Tennessee* was part of a plan by the Navy Department of the Confederacy for the defense of Mobile Bay. She was built at Selma, Alabama and commissioned 16 February 1864, becoming part of the defensive squadron of Admiral Franklin Buchanan with Commander James D. Johnston as her skipper. She had to be floated over Dog River Bar into Mobile Bay by means of huge caissons ("camels") because her deep draft. By the time she had gotten into the bay, Admiral David Farragut's Union fleet was readying itself for invasion. The ensuing Battle of Mobile Bay was a combination of iron will on the part of both the opponents and some



serious mistakes made by Buchanan's squadron (*Tennessee* with *Gaines*, *Morgan* and *Selma*--the latter three being only wooden gunboats). Though outnumbered and outgunned, *Tennessee* and Buchanan fought valiantly, although she was the only Confederate ship left at battle's end; and both Buchanan and Johnston were taken prisoner and sent north. *Tennessee* was used by the US Navy after this in its mopping up operations as a member of the Mississippi River Squadron after the war. She was then decommissioned for two years in New Orleans and then sold for scrap in 1867--quite an ordinary ending for such a gallant, extraordinary ship! Perhaps she deserved a better fate, but she was obsolete and not yet five years old!

In further review of the problem of turning out classy ships in the Confederacy, it is not enough to mention inexperience and poor planning from the top down, inadequate transportation, or an inflexible economy. By examining the career of CSS *Tennessee*, one can see that organization and administration were as much at fault as the aforementioned deficiencies. There were not enough experienced river pilots, nor were there enough engineering officers to be had.

### SPECIFIC COGNITIVE SKILLS ASSOCIATED WITH FORMAL REASONING

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The trend toward increasing accountability in higher education in the face of a population of students who are poorly prepared to reason formally and solve problems appropriately presents a challenge to the teaching profession. An initial step in teaching to enhance cognitive development is defining and measuring specific cognitive skills involved in problem-solving and formal reasoning. This study isolated students at three reasoning levels described by Piaget--formal operational, transitional, and concrete operational. Six specific cognitive skills--thing-making, qualification, classification, structure analysis, operation analysis, and analogy--were measured in students at each level. Correlation among the skills indicated a clustering of them into analogy and classification. An analysis of variance demonstrated significant differences in the thinking skills across the reasoning levels. The implication for higher education is that specific skills associated with formal reasoning can be described and measured; thus, methods to teach these skills can be developed.

### A BRITISH AESTHETE VISITS THE SOUTH

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In 1882, at the time of Oscar Wilde's lecture tour in America, he was almost unknown as a writer. It was to be a full decade until the publication of the superbly written novel, *The Picture of Dorian Gray*,



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or of the publication or production of his first play, *Lady Windermere's Fan*.

The public had, however, become aware of the young aesthete, for he had been the subject of numerous cartoons by George Du Maurier, the popular cartoonist of *Punch*, and had been identified as the prototype of Benthune, the leading character of Gilbert and Sullivan's newest musical comedy, *Patience*. He was, at the time, generally thought of as the young man who walked down Picadilly with a lily in his hand.

Much has been written about Oscar Wilde's discovery of America, although little attention has been given, even by his most recent biographer, to his brief stay in America. This paper is concerned with Wilde's impressions of Alabama, especially of Mobile and Montgomery, and with the impact of the young lecturer on these and some other southern cities.

### OBSERVATIONS ON THE 1791 FLOODS IN ALABAMA

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Torrential rains beginning on the "Tides of March"--March 15, 1791--and again on March 18 and 19 caused the Alabama River to rise twenty-five feet above its normal level, an extraordinary circumstance unknown in the memory of any settler or even among the Indians. Loss of crops, livestock and all but a handful of buildings at Fort San Esteban de Tombecbé (St. Stephens, the Spanish post established in 1789) and spread destruction across the Tensaw and Tombigbee valleys. There were no casualties, however, and a benevolent Spanish government attempted to provide relief, recovery and rehabilitation. For starters, 200 barrels of corn were sent to commandants in the Mobile District, and those who had lost everything could draw on funds for New Settlements to buy seed and replace lost tools and equipment. To prevent speculation by merchants hoping to make a profit from the suffering, Commandant Vicente Folch y Juan at Mobile issued ceilings on the price of corn at 65¢ a barrel on the cob and \$5.00 a barrel in seed. The chain of command found support for the flood victims at all levels--Mobile to New Orleans to Havana to Spain. *Noblesse oblige* characterized Spanish colonial administration, contrary to the mistaken notion of inept, wicked, tyrannical and crooked Spanish actions.

### TO SAVE HIS SOUL: JOHN WESLEY IN GEORGIA

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John Wesley arrived in Georgia in 1736 with the intent of serving as a missionary to the Indians. He hoped not only to spread the gospel to these people, but to attain salvation for himself by working with them. Having settled down, instead of being a missionary, Wesley found himself serving as parish priest to the Savannah community. Many members

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of his congregation disapproved of his strict adherence to the rules of the English church. He was also outspoken in regard to civil matters, thus alienating himself from many of the colonists. Finally, Wesley believed that he would no longer have to contend with the temptation of women in Georgia. He was mistaken, as he fell hopelessly in love with a member of his congregation. This romance directly led to his departure from the colony nearly twenty-two months after he had arrived. Wesley's attempt to find salvation through his ministry to the Indians had failed. He did, however, come into contact with a German religious group, the Moravians, which clearly set him on the right road to salvation. Hence, Wesley's venture to Georgia was not made in vain.

### THE IMPACT OF ALABAMA'S POPULATION TRENDS ON THE REORGANIZATION OF LABOR, 1865-1880

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Economic devastation and social disruption in post-war Alabama were complicated by white employer dissatisfaction with both the quality and quantity of free black labor. The former slaves' adjustment to freedom combined with the state's political instability and violence frequently resulted in black migration within the state and emigration out of Alabama. Those who remained on plantations rejected the old slave discipline and control. In response, planters attributed their difficulty in adjusting to the new labor system to a lack of cooperation and the unreliability of former bondsmen. Consequently, some employers looked to the North, Europe and even China for immigrant labor as a solution to labor problems.

Early efforts to increase Alabama's labor force were designed to induce the immigration of German workers. Experiments with German immigrant labor were infrequent, isolated, and had only minor success. Another alternative involved the feasibility of supplementing black labor with Chinese immigrant labor which was a controversial matter. Those who supported the use of Chinese workers waited in vain for the first 500 immigrants expected to arrive in Alabama in 1869. Opponents contended that it was folly to exchange the freedmen for Chinese, and proposed that white workers from the northern states might serve as a better substitute. Despite all attempts by state government, private organizations and individuals, few immigrant laborers arrived in Alabama between 1865 and 1880.

Since attempts to supplement or supplant black workers with immigrant labor failed, the migration patterns of the freedmen were extremely significant in the reorganization of labor in Alabama. Factors such as economics, politics, and violence contributed to black migration within the state and emigration out of the state.

Economic incentive and adversity affected migration patterns. Freedmen tended to gravitate to areas where their labor was needed and

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job opportunities prevailed. Economic adversity precipitated by the panic of 1873 reduced job availability and prompted some black workers to leave Alabama.

Changed political conditions, freedmen voting and holding office for the first time, and white employer resentment resulted in some forced black migration. Political factors combined with social pressures stemming from emancipation stirred some white Alabamians to vent their frustrations through violent actions against freedmen. Activity of the Ku Klux Klan in northern Alabama and vigilante action perpetrated against blacks in southern counties affected migration patterns. The aim and impact of the violence was to either drive the freedmen into the central, traditionally black-populated counties, or to force the former bondsmen out of the state. Whether prompted by social, political, or economic factors, black population trends in Alabama between 1865 and 1880 resulted in a polarization of white and black population, some emigration, and continued reliance on the former slave as the main source of labor.

### IN RETROSPECT: ONE HUNDRED YEARS OF REFORM JUDAISM IN HUNTSVILLE

Marsha Kass Marks  
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Jewish people began to arrive in Huntsville possibly in the 1840's and Jewish marriages occurred here at least as early as 1855. These first pioneers were primarily merchants and cotton factors. They began to prosper very late in the ante-bellum period, some beginning to acquire important real estate in Huntsville and the surrounding areas in 1860. The first known Jews in Huntsville were Robert Herstein and Morris Bernstein; both were listed in the 1859 Huntsville City Directory. After the war a number of Jews moved to Huntsville from Cincinnati. At a meeting in the Masonic Hall on September 10, 1876, eighteen men formed B'nai Sholom congregation.

In 1898 land was purchased at the corner of Lincoln and Clinton Streets, and the present Temple building was dedicated on November 26, 1899. After World War II, the Jewish population of Huntsville mushroomed. Many of these new arrivals joined the congregation and the Religious School required more classrooms. The Educational Building, begun in 1967, was completed in 1968 at a cost of \$100,000. In 1975 renovation of the sanctuary was undertaken and completed.

From its inception, the Huntsville Jewish community, while coping with its own needs and difficulties, clearly involved itself in the life of the city, sharing and reflecting its activities, problems, and growth.

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### BILLY WEATHERFORD IN THE CREEK WAR: A CRITICAL ESSAY IN BIBLIOGRAPHY

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Billy Weatherford, a Creek Indian, is one of Alabama's more controversial folk-heroes to come out of her early history. Billy's physical part in the Creek War of 1813-1814 has been established. But his motives and actual movements remain under controversy.

Billy was at the Fort Mims Massacre (August, 1813). But his reluctance to support the massacre 100% has been attributed to several things: His relatives and friends who were in the fort at the time, his noble effort to stop the hostile Creek Indians from waging a war they couldn't win and cowardice.

During the Battle of Holy Ground Town (Dec., 1813), Billy found himself surrounded by the U.S. Army. To escape them, he took the celebrated Weatherford's Leap. The questions are whether he jumped or rode to the bottom of the bluff, and how high the bluff was.

His surrender to Andrew Jackson after the Battle of Horse Shoe Bend (March, 1814) is his most famous act. Billy's reason for surrendering range from selflessness to selfishness. But the great controversy stems around the words exchanged between Weatherford and Jackson.

Within the last fifty years, a lot of the myths have been debunked. But this has not stopped the stories about Billy Weatherford. Alabama has a firm grasp on her hero and intends to keep him there.

### THE REORGANIZATION AND EARLY SERVICE OF THE TWENTY-THIRD ALABAMA INFANTRY REGIMENT, C.S.A.

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The Twenty-third Alabama Infantry Regiment of the Confederate Army was formed in October, 1861, from companies raised separately in nine south Alabama counties. Four companies from Wilcox, Clarke, Marengo, and Conecuh counties were consolidated into a battalion at Camden in September under the command of Franklin King Beck. In Montgomery Joseph Bibb brought six companies from Conecuh, Macon, Lowndes, Choctaw, and Baldwin counties under his command in an effort to gather the necessary strength to form a regiment. Beck's proposal that they unite their commands resulted in the creation of the regiment with Bibb as colonel and Beck as lieutenant colonel. After a brief period of training in Montgomery the regiment, armed by private enterprise and the State of Alabama, was ordered to Mobile to boost the strength of Braxton Bragg's Department of Alabama and West Florida. For two and one-half months the unit served garrison duty in the unhealthy camps along the Dog River

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below Mobile, continued its training, and suffered numerous losses to disease. No Federal attempt was made against Mobile, and in February, 1862, the regiment was ordered to Knoxville to join Kirby Smith's Department of East Tennessee. Subsequently it would serve with distinction in the central theatre until its surrender at Salisbury, North Carolina, in April, 1865.

### SHORT HISTORIES OF THREE ACTING GOVERNORS OF ALABAMA IN THE ANTE-BELLUM PERIOD

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and

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The Tennessee Valley before the Civil War was one of the most important political regions in the state, yet it is most unusual that the only three men to serve as acting governors of Alabama during the ante-bellum period were from the Tennessee Valley. They were Thomas Bibb of Lime-stone County, Samuel B. Moore of Jackson County and Hugh McVay of Lauderdale County.

The Bibb family stands pre-eminent in early Alabama history. Six of eight brothers settled in Alabama. Two became governors, the first and second chief executives of Alabama; a third was a prominent lawyer and judge of the criminal court of Montgomery, while a fourth served in the Alabama Legislature before moving to Mississippi. Thomas Bibb served as acting governor, succeeding his brother William when he died from a fall from a horse on July 9, 1820. He chose not to run for governor after finishing out his brother's term.

Smauel B. Moore has the distinction of being the only governor of Alabama from Jackson County--and of having served one of the briefest periods in that office.

For most historians the highlight of McVay's political career actually came in 1836, when he was elected president of the Senate, defeating Samuel Moore by one vote. In June of the next year, Gov. Clement Comer Clay of Huntsville resigned to become a U.S. senator. As president of the state Senate, McVay replaced him as governor in July. He discharged the duties of the governorship until the inauguration of Gov. Arthur Bagby in December.

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### PROJECTIONS OF LABOR FORCE PARTICIPATION RATES, UNITED STATES, 1975-2035

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The purposes of this paper are to present projections of labor force participation rates by age group and sex for the United States and to describe the methodology used to prepare these projections, which were developed as a part of a larger study for the Crops of Engineers. Two different methods were used for projecting labor participation rates, one for male rates and the other for female. The equation for the male labor force participation rate was chosen to provide the necessary upper or lower asymptote in all age groups. The equation for the female labor force participation rate was chosen such that, in each age group, the lower asymptote for the male labor force participation rate becomes the upper asymptote for the female labor force participation rate. The total labor force participation rate of each age group was obtained by weighting the projected male labor force participation rate and female labor force participation rate by the male population and female population above 16 years of age.

The total male labor force participation rate for the year 2035 is projected to 79.72. The total female labor force participation rate is projected to increase from 44.73% in 1975 to 60.65% in the year 2035. The total labor participation rate for all groups is projected to increase from 62.68% in 1975 to 69.85% in the year 2035.

## HEALTH SCIENCES

### BIOELECTRICAL EFFECTS OF MECHOLYL ON THE SURFACE CELLS OF MUDPUPPY GASTRIC MUCOSA, IN VITRO\*

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3 m KCl filled microelectrodes were used to measure intracellular electrical potentials from surface cells of *Necturus maculosus* (mudpuppy) fundus gastric mucosa, in vitro. Simultaneous recordings were obtained from  $V_{MN}$ ,  $V_{MS}$ ,  $V_{SN}$  (M = microelectrode, N = nutrient or serosal solution, S = secretory or lumen solution); also recorded were  $R_T$  (transmucosal resistance, and  $RS/RN$  (ratio of membrane resistances). The microelectrode tip resistance averaged 15 Meg ohms. As previously reported (Am. J. Physiol. 219:1056, 1970) mecholyl produced a hyperpolarization in  $V_{SN}$ , and a reduction in  $R_T$ . This effect was not obtained in  $Cl^-$  free solutions ( $SO_4^{2-}$  replacing  $Cl^-$ ) and was blocked by atropine.



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A summary of the results from ten experiments is listed below:

	$V_{MN}$ (mv)	$V_{MS}$ (mv)	$V_{SN}$ (mv)	$R_T$ $\Omega\text{cm}^2$	RS/RN
Control values	-71	-49	-22	825	8
Values at maximum voltage change	-80	-51	-29	450	3

The change in RS/RN  $\neq \frac{\Delta V_{MS}}{\Delta V_{MN}}$  (Exp. condition-control values); therefore

the change in volage across the survace cell after mecholy1,  $10^{-6}\text{M}$  added to nutrient, could not be explained by assuming the surface cell was a passive shunt, i.e., the  $\Delta V$ 's could not be explained by an  $iR$  drop across surface cell membrane due to current flow from the oxyntic cell. But the change recorded could be explained by assuming that mecholy1 increased the  $\text{Cl}^-$  emf on the nutrient membrane of the surface cells.

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\* NSF Grant Support

### TWO DIMENSIONAL ELECTROPHORETIC ANALYSIS OF HUMAN ERYTHROCYTE PLASMA MEMBRANE PROTEINS

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A two step combination of SDS-acrylamide gel electrophoresis followed by isoelectric focusing on thin-layer Ampholine-containing polyacrylamide gels was used to analyze SDS-solubilized components from human erythrocyte membranes.

Well washed erythrocyte plasma membranes were prepared from outdated human blood according to the procedure of Dodge (1963). Following solubilization in 1% sodium dodecyl sulfate (SDS), the peptides were fractionated into 25 components on SDS-containing polyacrylamide gels basically by the procedure of Neville and Glossman (1971). The molecular weights ranged from approximately 150,000 to below 20,000 as estimated from parallel migration of standard proteins. Separation of these peptides in the second dimension was accomplished by fusing an unstained and unfixed SDS-disc gel to a thin layer acrylamide gel prepared for isoelectric focusing. Results of the focusing show approximately 9 components thus suggesting that several peptides of different molecular weight either have similar amino acid composition and similar net charge or recombine in this step. Using 12 M urea on the focusing plates did not appear to improve the results.



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### A HISTOCHEMICAL AND ELECTRON MICROSCOPIC STUDY OF BLOOD PLATELET FACTOR-3: STORAGE AND AVAILABILITY

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Blood platelet factor-3 (PF-3) plays a key role in the process of intrinsic coagulation. Previous investigators have reported biochemical and electron microscopic evidence which proposes either a platelet membrane or a granule location for PF-3. In order for PF-3, a phospholipoprotein, to become available for interaction with circulating plasma clotting factors either cell coat would have to be removed to expose plasma membrane or some masked form of PF-3 would have to be released from a cytoplasmic granule.

The present study used ruthenium red, horseradish peroxidase (HRP), dialyzed iron, Concanavalin A-HRP, and periodic acid-TCH-silver proteinate to determine the distribution of platelet coat material. The lysosomal enzymes acid phosphatase and aryl sulfatase were used to identify alpha granules.

Uniform staining of the coat material was interrupted by the apparent release of membranous vesicles from the platelet surface. The membranes, vesicles, or blebs were not stained by any of the techniques used to localize coat material. Acid phosphatase and aryl sulfatase activity was localized in the platelet alpha granule, but was not seen in all granules within all platelets. The blebs protruding from the platelet surface demonstrated only aryl sulfatase activity.

These observations support the hypothesis that PF-3 is located within the alpha granule in a masked form. The results also suggest a heterogeneous population of granules. Some membrane-bound granules containing aryl sulfatase are made available on the platelet surface. Other alpha granules containing acid phosphatase may not be released until secondary aggregation.

### CARDIAC ENLARGEMENT FOLLOWING MULTIPLE ROUTES OF INJECTION OF ORAL CONTRACEPTIVE STEROIDS IN THE CHICK EMBRYO

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Oral contraceptive agents have been shown to produce a deleterious effect on human fetal cardiovascular development. In the chick embryo, a marked cardiac enlargement has been described using large doses of Enovid, a potent oral contraceptive compound. In the current study an attempt was made to reduce the concentration of Enovid administered to the chick embryo.

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Ethanol-saline (3 parts absolute ethanol:2 parts of 0.9% saline) containing as little as 0.3 mg of Enovid was found to be a better carrier solution than corn oil previously used for steroid delivery to the chick embryo. The allantoic cavity injection route was superior to the air sac route in reducing overall mortality without compromising the cardiac enlargement response. Strain differences were not significant with respect to the latter.

Steroid-induced cholestasis in the chick embryo liver which resulted in bright-green livers compared with the normal yellow-brown hepatic coloration was almost always observed with cardiac enlargement. Similar cholestasis (inhibition of bile release from the liver) has been described in some women on the "Pill." The apparent interaction between the liver and heart which results in cardiac enlargement is not understood; neither is it known whether the cardiomegalic response is caused by hypertrophy or hyperplasia or both.

### PRESERVATION AND QUANTITATION OF ACID MUCOPOLYSACCHARIDES IN TISSUES BY CETYL PYRIDINIUM CHLORIDE FIXATION AND ATOMIC ABSORPTION SPECTROPHOTOMETRY

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Some investigators claim that cetyl pyridinium chloride (CPC) preserves acid mucopolysaccharides (AMPs) in tissues. This study was made to test that hypothesis quantitatively.

Representative tissues of the adult rat, hamster, and man were bisected. One piece was fixed in 10% neutral buffered formalin (NBF) containing 0.5% CPC and the other in 10% NBF only. Other samples obtained at the same time were divided and fixed with or without CPC for electron microscopy.

Deparaffinized and hydrated sections of the formalin fixed tissues were stained with alcian blue (AB) 8GX to show AMPs. Washed and dried sections were scraped from the slides and weighed. Each tissue sample was placed in a test tube, dissolved with nitric acid, and the copper concentration determined by atomic absorption spectrophotometry (AA). The quantity of copper, a constituent of AB, reflects the concentration of AMPs in the tissue (expressed as  $\mu\text{g Cu/mg dry tissue}$ ).

The results clearly showed that CPC enhanced the preservation of AMPs. Values for human trachea were 5.1 with CPC and 3.5 without CPC. Values for duodenum, skin, heart, and kidney were also greater with CPC. Interestingly, sex differences in AMPs were found in certain hamster tissues. Submandibular gland values for males were 4.8 (with CPC) and 4.4 (without CPC) while corresponding values of 6.2 and 5.9 were obtained for females. In contrast, values for sublingual glands and duodena were higher for males. Electron micrographs showed that CPC stabilized

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intracellular AMPs, particularly sialomucins, and illustrated conclusively the mechanism of action of CPC at the cellular level.

### INDUCED GROWTH CHANGES IN IMMATURE RAT PAROTID GLAND

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Compensatory enlargement has been described for a number of organs, but little is known about this phenomenon in salivary glands. This research was undertaken to determine whether the usual growth patterns of parotid gland of the immature rat could be modified during postnatal development by bilateral extirpation of the other major salivary glands.

Removal of the submandibular and sublingual glands in postweanling animals resulted in a 30-50% increase in gland weight, 20-27% enlargement of cell size, and 47-92% elevation in total gland amylase. The extent of these increases was dependent on the age of the animals at the time of partial desalivation and the length of time between desalivation and sacrifice. A marked increase in the size of and a change in the staining of secretory granules within acinar cells occurred in toluidine blue-basic fuchsin stained sections from enlarged glands. Little change in gland size, cell size, secretory granules, mitotic index, or total gland amylase was seen in preweanling animals.

The induced compensatory enlargement was due to cellular hypertrophy rather than to hyperplasia, since cell size was increased in experimental animals, but no increase in mitotic index was observed. A relationship between the time of desalivation and weaning was found to be a critical factor in the induction of the compensatory response. It was only when the period following desalivation extended beyond weaning that compensatory enlargement occurred. Preliminary denervation studies reveal that a neural regulation of the compensatory response is involved in postweanling but not in preweanling animals.

### RESPONSE OF THE RAT PAROTID GLAND TO CYSTIC FIBROSIS SERUM

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Schneyer and Wilborn (1976) showed that injections of serum from human patients with cystic fibrosis into adult rats caused alterations of the acinar cells of the parotid gland (Cell Tiss. Res. 169: 111). Changes were first noted after 2-3 days of serum injections (0.2 ml/day). The purpose of the present study was to determine if changes could be observed with a single serum injection after an interval of only 3 hours.

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Three groups of rats were injected intraperitoneally with 0.2 ml of one of the following: Group I, normal saline; Group II, cystic fibrosis serum (CFS); Group III, normal human serum (NHS). Three hours after injection, rats were sacrificed with Nembutal and the parotid glands were removed for histological, ultrastructural and biochemical studies.

CFS caused pronounced structural alterations of the parotid gland, resulting in acinar cell hypertrophy, degranulation, and an increase in lysosomes and autophagic vacuoles. These same kinds of effects were observed after NHS, but they were greatly reduced in magnitude. Parotid amylase levels were significantly lower and serum amylase levels were higher in rats injected with CFS than in rats receiving NHS or saline.

It was concluded that a single injection of CFS caused striking changes in the parotid gland within 3 hours. These results further indicate that the rat parotid may have potential usefulness in assaying for the presence of the cystic fibrosis factor(s) in human serum.

### THE EFFECTS OF A SYNTHETIC CATECHOLAMINE ON RAT SALIVARY GLANDS

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The synthetic sympathomimetic drug dimethylepinephrine, commonly known as isoproterenol (ISP), has been shown to cause hyperplasia and hypertrophy in secretory cells of rodent salivary glands. ISP-induced alterations in immature rat submandibular glands include a modification of the secretory product as well as the presence of atypical secretory granules (Lab. Invest. 30: 341, 1974). This study has been conducted to compare the effects of chronic ISP treatment on the histological and morphological features of immature rat parotid and submandibular glands. Parotid and submandibular gland tissue was obtained from normal 18 day old rats and rats injected with ISP twice daily for 8 days. The tissue was fixed and processed for electron microscopy and embedded in epoxy resin.

Light microscopic observations of  $1\mu$  epoxy sections stained with toluidine blue and basic fuchsin reveal similar histological alterations in the parotid and submandibular secretory cells of ISP treated animals. ISP induces the formation of large, basic fuchsin staining granules in the secretory cells of both glands. This suggests a modification of the granule contents has occurred. Alterations in the secretory granules have been verified by electron microscopy. Large electron lucent granules containing fine filamentous material are induced by ISP in the parotid and submandibular secretory cells. These modifications seem more drastic in the parotid cells since they normally contain small electron dense granules containing digestive enzymes. These results suggest that the stimulus imparted by ISP may similarly alter the function and morphology of two types of cells in functionally different glands.

THE EFFECT OF A CHEMOTHERAPEUTIC AGENT ON HUMAN  
DENTAL PLAQUE AND GINGIVITIS

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Dental plaque is regarded as a predominant etiological factor in dental diseases. Safe effective antibacterial agents have been searched for because elimination of plaque by personal oral hygiene is not achieved by many individuals. Alexidine, a bisbiguanidine, has reduced plaque and gingivitis in animals and in small groups of humans studied for short periods. Our purpose was to determine the effectiveness of an 0.035% alexidine mouthwash in reducing plaque and gingivitis in humans continuing their usual oral hygiene over a six month period. Also, we evaluated the safety of six months continuous use of alexidine and determined its effect on tooth staining.

Two hundred forty adults, assigned randomly to either an active or placebo group, rinsed for 1 minute twice daily. On day 0, a history and oral examination were done. Tooth staining was assessed, gingival status was graded based on surface characteristics and by bleeding on probing, and plaque was scored using the Quigley-Hein Index. Saliva samples were taken to monitor changes in oral microbiota. Blood and urine samples from 1/3 of the subjects were analyzed. Examinations similar to the first examination were done at days 30, 90 and 180.

A statistically significant reduction in plaque was found in the active group. Greater reduction of gingivitis also occurred in this group and was statistically significant at the 30th and 90th day. No significant adverse reactions were noted in oral or systemic parameters other than removable brownish extrinsic tooth staining, predominantly in the active group. *Under the study conditions, alexidine was effective in reducing plaque and gingivitis.*

THE SIX NOBEL PRIZES AND AMERICAN LAUREATES

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Alfred Bernard Nobel invented dynamite and blasting gelatine and accumulated a large fortune. He bequeathed \$9,000,000, the interest of which was to be distributed yearly to those who had most benefited mankind the previous year. The Nobel Foundation was established in 1895 and the first Nobel Prizes were awarded on December 10, 1901. Only nine native Americans received Nobel Prizes up to 1930: one, chemistry; two, physics, one, literature; and five, peace. Native Americans have received Nobel Prizes in all categories since 1931. If we consider only native laureates of the countries that have received a majority of the prizes through 1976, we find that America has won the most: America, 103; Great Britain, 60; Germany, 53; and France, 34.

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Due to either the destruction of laboratories in Europe during World War I or the influence of dictators, 42 scientists emigrated to the United States of America. Most of them became naturalized and all of them received Nobel Prizes. Thirteen scientists emigrated to Great Britain and they won Nobel Prizes.

The number of American Laureates in each of the categories is impressive: Physiology and Medicine, 53; Physics, 41; Chemistry, 22; Peace, 16; Literature, 7; and Economic Sciences, 6.

### NATURAL FAMILY PLANNING

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A review of the literature related to fertility factors in the female reveals much information that can be applied to the clinical practice of nursing. The desire for naturalness and fear of damaging side effects stimulated public interest in fertility awareness. The utilization of knowledge of fertility factors can be used to plan or prevent a pregnancy.

A scientific basis exists for the natural methods as a result of research efforts of physiologists, physicians, and nurses who are studying reproductive function and infertility. Physiological signs and symptoms that can be observed by the client are quantity of cervical mucus, spinnbarkeit, body temperature, ferning, cervical dilatation, cervical height in the vagina, mittelschmerz, and midcycle spotting. These physiological signs are the result of the influence of estrogen and progesterone on the woman's body.

Four methods of natural family planning are nationally recognized: calendar rhythm, basal body temperature, ovulation method, and sympto-thermal method. The two latter methods are becoming popular. Research comparing the ovulation and the sympto-thermal methods is being conducted in various parts of the country.

### THE EFFECTS OF PATIENT POSITIONING AND MODES OF TRANSFER ON ENERGY EXPENDITURE, HEART RATE AND BLOOD PRESSURE

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Nurses are often responsible for prescribing modes of transfer for patients from one place to another and for placing them in various positions. With knowledge regarding effects of positioning and transfer on energy expenditure (EE), heart rate (HR), and systolic and diastolic blood pressure (SBP/DBP), nurses should be better able to prescribe patient positioning and transfer activities. Purposes of this study were:



1) to establish reference values for EE, HR, SBP and DBP for normal healthy females assuming common hospitalized patient positions and modes of patient transfer; and 2) to compare these parameters in the various positions and during transfer.

M.A.M.A., a mobile automatic metabolic analyzer built by N.A.S.A., an open circuit method for indirect calorimetry, was used. Five positions, six minutes in each, were assumed by 34 subjects: semi-fowlers #1, dangling, wheelchair, semi-fowler #2, and stretcher. ANOVA and t tests were applied.

Among several conclusions were: 1) the move from dangling to the wheelchair is more desirable in terms of its effects on EE, HR and DBP than the move from semi-fowlers to the stretcher; 2) maintaining the wheelchair position is more desirable in terms of its effects on HR and DBP when compared with maintaining the stretcher position; 3) the move from stretcher to bed when compared with the move from wheelchair to bed is more desirable in terms of its effects on EE and DBP; 4) SBP has not been shown to be a significantly varying parameter in either maintaining positions or in various modes of transfer; 5) energy expenditure, heart rate and diastolic blood pressure have been shown to be useful parameters in determining differences among modes of transfer.

### NURSING INTERVENTION VIA HOME VISITATION IN IDENTIFIED NON-COMPLIANT HYPERTENSIVE ADULTS

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Nurses, as providers of health care in communities, have long been aware of the difficulties encountered when caring for adults who have essential hypertension. It is becoming increasingly apparent that the greatest roadblock to successful long term care involves compliance to prescribed therapy.

The purpose of this study was to determine if nursing intervention involving home visits by fourth year B.S. nursing students could be effective in reducing identified non-compliant behavior of hypertensive adult patients. Also, an attempt was made to identify changes in patients' verbal responses to a questionnaire with a "worry" factor relating to himself, his family, his disorder and other significant variables in his life. In addition, a tool designed to compare the patients' perception of how well he followed medical recommendations was compared with a similar tool completed by the nurse.

The experimental study involved 58 patients (mean age 63) determined to be non-compliant in at least one of 4 specific areas (weight, blood pressure level, serum cholesterol level and/or appointment breaking behavior). During the study period (3 months) home visits were provided to the experimental group (19 patients).



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Analysis revealed no significant improvement in identified compliance behaviors in the experimental group. This was not unexpected in terms of the time limitations of the study. However, verbal response to the questionnaire containing the "worry" factor revealed significant change in sections dealing with "Functional Ability" and "Finances" in the experimental group.

Thus it would appear that the nurse can be a significant factor in providing emotional support to clients and in assisting them to relate to their illness in a more positive manner.

### INHIBITION OF THYROID PEROXIDASE BY 2-SELENOURACILS

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Thyroid peroxidase is the enzyme responsible for the organification of iodide and the subsequent synthesis of hormones in the thyroid gland. The primary action of the thioureylene group of antithyroid drugs is to inhibit the activity of this enzyme. The objective of this study was to synthesize and determine the antiperoxidase activity of thioureylene analogs in which the sulfur was replaced by selenium, an element in the same group of the periodic table as sulfur and oxygen. The procedures employed in the synthesis of selenouracil and propylselenouracil were modifications of those used in the production of thiouracil and propylthiouracil in that selenourea rather than thiourea was a starting material. The antiperoxidase activity of these compounds was measured by determining their effects on purified porcine thyroid peroxidase catalyzed iodination of bovine serum albumin (BSA) using  $\text{Na}^{125}\text{I}$ . The iodinated BSA was separated from unreacted  $^{125}\text{I}$  by gel chromatography and the degree of iodination determined using a well counter.

Selenourea, selenouracil and propylselenouracil were compared with their respective sulfur analogs to determine relative antiperoxidase activities. In each case the concentration of selenium compound which produced 50% inhibition of the control peroxidase activity was comparable to that of its sulfur analog. These results demonstrate that active antiperoxidase compounds are produced by replacing the sulfur in thioureylene antithyroid drugs with selenium. This is contrary to previous findings in which other substitutions for the sulfur resulted in compounds having essentially no antiperoxidase activity.

### SUPEROXIDE DISMUTASES IN MYCOBACTERIA

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Previous investigation has indicated that catalase may have an important function in rendering mycobacteria sensitive to the antitubercular drug isoniazid (INH). Since superoxide dismutase (SOD) may act in

concert with catalase in oxidative metabolism, studies were done to determine whether SOD might have a corelationship with catalase in mediating the mycobactericidal action of INH.

Based on electrophoretic mobility, INH sensitive and resistant *Mycobacterium phlei* (ATCC 345) were shown to contain three SOD isozymes, one of which was thermostable. *Mycobacterium tuberculosis* contained only one SOD. The level of SOD activity in cell-free extracts was independent of the organism's sensitivity to INH. INH at concentrations up to 0.1M had no effect on SOD activity of INH sensitive or resistant strains. Hence from these data it appears that SOD does not have a role in rendering the mycobacteria sensitive to INH; however, differences in SOD enzymes do exist between mycobacterial species.

SOD activity was demonstrated in whole cells of *M. phlei* and isolated washed membranes. It is suggested that the whole cell SOD activity may be attributable to membrane bound SOD(s) exposed to the surface of the bacterium. Such localization of SOD may contribute to the ability of mycobacteria to persist as intracellular parasites by protecting the organism from the toxic effects of oxygen anions generated by phagocytic cells *in vivo*.

## HUMMEL'S EQUATION APPLIED TO ENZYME ASSAYING

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Hummel's equation, derived from the equation for radioactive decay, has been previously reported (J. Acad. Sci. 45, 280 (1974)) in the form  $1/x = 1/a + 1/akt [1-g(t)]$ , in which  $x$  represents the product concentration,  $a$  the initial substrate concentration,  $k$  the velocity constant,  $t$  the time and  $g(t)$  a bending factor which has little influence during the first half of the reaction. The plotted curve of  $1/x$  versus  $1/t$  describes a trajectory which is nearly linear up to and beyond the midpoint. To simulate an ordinary enzyme reaction during the first half period, holding a constant and using assumed values of  $t$ , values of  $x$  were calculated to five places using the exponential equation. The plotted results of  $1/x$  versus  $1/t$ , for three supposed enzyme concentrations, formed a family of almost straight lines with nearly identical extrapolated intercepts on the  $1/x$  axis. The average of the intercepts can be taken, with little error, as a common point on all curves in the family. With this information it is possible, using the two point slope formula, by means of a single determination of the product concentration at any convenient time within the half period, to calculate approximately the initial velocity  $ak$ , which is a true measure of enzyme activity. Since, within a family of such curves, the slight individual deviations from linearity are of like magnitude, the usual practice of comparing an unknown with a standard gives results whose deviation is no more than 0.25%, well within the limit of experimental error.

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### COMPARATIVE ACTIVITIES OF MITOCHONDRIAL ENZYMES IN HEARTS, BRAINS AND LIVERS OF MICE AND RATS\*

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Mitochondrial fractions were prepared from hearts, brains and livers: of 94 individual E-LE rats (approximately equal numbers of males and females); of 6 pools of 3 each Balb/c female mice; and of four male Fisher 344 rats raised under germ-free conditions by Charles River Breeders for the NIA. The ages of the E-LE rats and of the groups of mice were distributed throughout the lifespans of these species. The NIA rats were approximately 900 days old.

Specific activities of cytochrome oxidase, succinate dehydrogenase, glutamate-oxaloacetate transaminase, 3-hydroxybutyrate dehydrogenase and glutamate dehydrogenase of these preparations were determined. Statistical group comparisons were done.

No significant ( $p \leq 0.01$ ) differences were found in any organ in the oldest group of male E-LE rats (5) and the NIA rats.

When the six groups of mice and all the E-LE rats were compared, significant differences were noted in only three cases: succinate dehydrogenase specific activities of rat heart and brain were greater than those of mouse heart and brain; rat liver glutamate-oxaloacetate transaminase was less than that of mouse liver.

These results indicate that different strains or species of rodents often have no specific enzymatic activity differences; however, enough occur to signal caution in applying values to other strains or species.

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### SALICYLIC ACID DIFFUSION AND INTERACTION IN POLYETHYLENE GLYCOL OINTMENT BASES

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Percutaneous absorption has been shown to be affected by obvious physiological factors. However the ability of ointment base constituents to affect drug release is less clearly understood. While the polyethylene glycols are useful as water-soluble ointment and suppository bases, little is known about their effect upon drug release. Drug

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diffusion from four water-soluble ointment bases was studied using a custom-made dialysis cell fitted with polydimethylsiloxane membranes. Ointments containing various molecular weight fractions of polyethylene glycols were formulated with salicylic acid. Drug release from these ointment bases was found to follow zero order kinetics and was related to the molecular weight of the polyethylene glycols used. Results showed addition of low molecular weight polyethylene glycols may adversely affect salicylic acid release from the base. While the mechanism is not clearly understood it may relate to interaction of salicylic acid with the lower molecular weight fractions. Alteration of pH in the receiving compartment of the cell did not influence salicylic acid release.

### STARRED SCIENTISTS IN AMERICAN MEN OF SCIENCE LISTED IN WORLD WHO'S WHO IN SCIENCE, 1968

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The editor of the first edition of *American Men of Science*, 1906, prefixed stars (asterisks) to the subjects of research of about one thousand biographical sketches. Approximately 250 were added to each of the next six editions. A star was voted by the peers of the scientist and it indicated that he was distinguished for his research. The star not only gave the recipient considerable satisfaction but also increased his opportunities for advancement. The custom caused institutions to increase their facilities for their starred members and for attracting other starred individuals. The starring system has been given credit for a major contribution to the growth of research in America.

However, since the names of the voting peers were not published and since a high percent of those that were starred had either earned a degree or served in some capacity as a staff member of one or more of the Ivy League Institutions, it was decided to compare the starred scientists with scientists who were selected by an international advisory council for the *World Who's Who in Science From Antiquity to the Present*, 1968.

The percent of the starred scientists in each of the first seven editions of *American Men of Science* who were also listed in *World Who's Who in Science* was as follows: 1906, 52.9%; 1910, 52.3%; 1921, 52.9%; 1927, 54.1%; 1933, 59.4%; 1938, 61% and 1944, 59.9%.

Were the voting peers influenced in their selection of individuals for starring either because of personal acquaintances or because of the fact that the scientists had been associated in some official capacity with the proper educational institution?

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### ENGINEERING

#### DIESEL ENGINES, COMBUSTION CHAMBERS, AND AIR POLLUTION

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In view of the current, and likely continuing, national energy and environmental crisis, any contribution which helps alleviate the crisis will be welcomed. The authors selected the diesel engine for research and development because of the promise it offers as a very economical prime mover which may meet government requirements without after-combustion correction devices by optimizing the design parameters of the combustion chamber. Additionally, diesel engines will operate on a number of diverse fuels.

To achieve optimum comparison between different diesel engine combustion systems, a test engine was developed so that the basic engine remains unchanged while design parameters of the combustion chamber are varied.

The air flow characteristics during the compression stroke of a prechamber system were calculated as a function of the design parameters: compression ratio, prechamber and main chamber volume ratio, and throat area connecting the main chamber and the prechamber. The air in-flow velocity and mass flow rate were calculated for various values of these parameters. The results obtained identified optimum inflow velocity into the prechamber and the corresponding mass flow rate.

Experiments were conducted on the test engine with an open-chamber and a prechamber configuration. As was expected, the prechamber configuration was more promising, producing substantially less  $\text{NO}_x$  and less smoke at rated power with only slightly higher fuel consumption.

Based on the results of the theoretical study of the prechamber flow characteristics, experiments were conducted to optimize the prechamber combustion system operational and design parameters. The results obtained concerning air pollution (primarily  $\text{NO}_x$ ) and fuel economy were satisfactory and promising.

#### THE FORMULATION OF A MODEL TO TEST AND EVALUATE THE DESIGN OF A DME/IMU NAVIGATION FILTER\*

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The development of operational software for integrating inertial measuring unit (IMU) and distance measuring equipment (DME) requires a simulation of the IMU and DME behavior. The simulation is used both for

development and analysis of the navigation algorithm and for checkout of the operational program.

The purpose of this paper is to formulate a simulation tool which can be used to evaluate the design of a DME/IMU navigation filter. This formulation is flexible in that it includes both real time and off-line capability. Specifically included are the theoretical construction and program flow for the following modules:

- Initialization (to provide required initial data for the test model)
- Flight (to provide the necessary aircraft flight trajectory)
- The inertial subsystem (which includes the baro-inertial loop, the modeling of necessary inputs and output IMU parameters and oblateness)
- The DME Range Generator (which comprises the modeling of the DME ranging data)
- The "motion" module (which provides the motion of another location in the aircraft with respect to the IMU stable element).

Simulation results are included to illustrate the application of the simulation to DME inertial system design.

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1400 Wilson Blvd.  
Arlington, VA 22209

Air Force Systems Command  
Rome Air Development Center  
Griffis Air Force Base, NY 13441

### OVERVIEW OF GUIDANCE SYSTEM DEVELOPMENT FOR A NEW CLASS OF TERMINALLY GUIDED WEAPONS

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An Army requirement had been established through various operational studies for providing additional firepower against tanks and other armored elements. The studies supported the conclusion that new weapon systems had to be developed to meet that threat. One of the concepts which was given a high probability of success in such an engagement was a projectile, launched from a gun, and then guided by tracking reflected energy from a target illuminated by a remote laser designator. Thus,



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the 155MM howitzer with semi-active laser homing guided munitions was conceived. As part of an Advanced Development (AD) program, effort was initiated at the US Army Missile Research and Development Command directed toward identification of potential problem areas within the mechanization of this concept, and to delineate approaches to their solution. In particular, the task was to insure that guidance and control systems and components would be developed to withstand the anticipated 10,000 g launch environment and guide the projectile to the target with unerring accuracy.

Efforts to validate the guidance and control system were directed primarily to a time frame immediately after all design freezes were made and just prior to initial flight tests of the weapon. A realtime hybrid computer simulation with hardware-in-the-loop was one method chosen to accomplish this important milestone along with numerous other laboratory tests. The tests included the sequential steps from laboratory breadboard subsystems, through ruggedized functional subsystems to full-up rounds for final demonstration of operational performance. Some of the tests included: Breadboard system functions, projectile aerodynamics using wind tunnel and gun launched vehicles, aircraft captive flights and air drops to simulate seeker acquisition characteristics, g-hardened survivability and soft recovery, laboratory emulated flights via hardware-in-the-loop simulations, and finally full-up gun launch flights. The gun launched flight tests of the recently completed AD program were at the White Sands Missile Range for firings at various target conditions. The predictions of the hardware-in-the-loop simulation and other test data are compared to the results of the flight test program.

### A PNEUMATIC ACTUATION SYSTEM FOR A LARGE BALLISTIC MISSILE

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Traditionally, large missiles have been controlled in post boost flight by hydraulic control actuation systems. Hydraulic systems possess the advantages of high stiffness, high response and high torque capability. They have the disadvantages, however, of being expensive and bulky. This paper describes a pneumatic control system that has been developed for a large ballistic missile as part of the Simplified Inertial Guidance Demonstration (SIG-D) program at MIRADCOM. The design offers the potential for a significant cost reduction over a hydraulic system to meet the control and stabilization requirements for a missile of this type.

The missile itself utilizes a strapdown inertial guidance system and digital processing for sensor signals and autopilot compensation. It is seen that the processing, autopilot design, and actuation system performance are intimately coupled, as characteristics unique to each subsystem drastically affect the performance of every other one. The basic control system design philosophy, mechanical design, modeling,



performance, and influence on the total missile system performance is discussed. Typical data on the pneumatic system is presented.

### COMPLEX RADAR TARGET CONSIDERATIONS

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When a complex target is in the near-field of a radar, the predicted location of the target can be distorted by phase-front errors known as glint. The modeling of target complexes is presented in this survey along with diversity techniques that can be used to reduce glint error. The literature presented within this survey points out that with the use of effective diversity techniques, glint error can be considerably reduced. The construction of reliable target models is required to study the effects of glint accurately. An overview of the above topics is discussed.

### RADAR WAVEFRONT DISTORTION PRODUCED BY AERODYNAMIC RADOMES

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The front of a missile must be streamlined in order to have minimum drag in flight. When a radar is located on the missile, the nose of the missile must be capable of passing the radar signal to and from the radar antenna. Such a streamlined protective antenna cover is known as a radome. Ideally a radome should have no effect on the radar signal passing through it, but it is not possible to build a radome that is transparent for all angles of the incident wavefront, so some radome-induced wavefront distortion always exists.

The radomes presented here are modeled as dielectric shells having ogive geometry. A ray tracing technique is used to predict the amplitude and phase distortion of a plane wave incident on the radome by assuming that the radome is a locally planar sheet. Any polarization may exist in the incident wave and it is seen that the wavefront distortion varies with polarization in general.

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### VALIDATING MODELS FOR HARDWARE-IN-THE-LOOP SIMULATIONS

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and  
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Before confidence is placed upon simulation results, model verification and validation must have been performed. In the case where hardware-in-the-loop (HWIL) simulation is to be used for gathering a large ensemble of performance statistics, the model verification procedure is afforded an additional level of information. It is not only desirable, but convenient to update mathematical models with data obtained in the HWIL simulation activity. Enroute to an acceptable HWIL simulation, however, many of the proven techniques for model validation are used to reach a simulation performance level commensurate with that expected from the hardware. Several methods and cases are documented in the paper for achieving this goal. The objective of this paper is to emphasize the utility of HWIL simulation as a major checkpoint in dynamic verification of flight hardware, while using the extensive data obtained, thereby, to validate and update the simulation models.

### SOME PROBLEMS IN EVALUATING COAL LANDS

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University of Alabama, University

Coal lands must be valued for many reasons in addition to the important purposes of buying and selling. The reason for seeking evaluation may influence that evaluation.

For undeveloped coal lands not valued for immediate mining, three methods are possible. These are: (1) discounted present value of future royalties; (2) some kind of formula method based upon location, physical conditions, coal quality and likely mining costs; and (3) the comparable sales method.

The problems with, advantages of, and shortcomings of all three methods are discussed and some modification of one formula method is proposed.

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### STREAM TEMPERATURES IN ALABAMA

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and

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Periodic temperature records have been made at most Alabama stream-discharge gaging stations and water-quality sampling stations since 1962 by federal, state, and municipal agencies. Continuous or daily-temperature records have been collected at 24 of these stations for at least 2 years since 1959.

This report summarizes and interprets most of these data, much of which is unpublished. Data from 168 stations were analyzed using a harmonic function to determine annual temperature variations. Three generalized zones of water temperature are delineated on a state map. From north to south, the average estimated mean annual temperature for each zone is 15.5, 16.7, and 17.9° C.

### PROVING STRIPPABLE RESERVES IN PART OF THE WORLD'S LARGEST CANNEL COALFIELD

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What has been stated possibly to be the world's largest cannel coal-field lies just east of the Rio Grande River, in the northern part of Webb County, Texas. Laredo is the county seat.

The author estimated the reserves of coal on two large tracts of land in the area using data from about 112 holes drilled in 1975.

The coal is true cannel of Eocene Age (Claiborne group). The geology and stratigraphy are discussed briefly. The structure of the coalbed is depicted on maps showing elevations on top of the principal coalbed. Isopach map show the variations and directional trends in thickness. Mineable coal reserves lying in beds one foot, or more, thick and under overburden of 100 feet or less, were calculated. The distribution of these reserves by probability category, for the two areas is given.

In addition to some statements about cannel coals as a class, the quality of coal from the two areas is shown. Also shown are washability data that indicate the quality of fuel that can be prepared from the raw coal at one locality in one reserve area.

The deposit, while probably not extremely large, is one of the best coal deposits to be found in Texas.

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### ANTHROPOLOGY

#### TUTANKHAMUN: PREVIEWS OF COMING ATTRACTIONS

Robert J. Fornaro  
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This paper introduces interested individuals to the artifacts and mentifacts that exemplify the cultural contributions of the ancient Egyptians of 1300 B.C. Background information is provided on Pharonic mummification rites and the cultural innovations of the Amarna Period. The rule and personality of the Amarna Period's most important Pharaoh, Akhenaton, is discussed with emphasis on his influence on the court of Tutankhamun. Representative artifactual examples from the Tutankhamun Exhibition now touring the United States were presented in conjunction with this paper.

#### IGNORANCE AND STEREOTYPING: THE MISREPRESENTATION OF SOUTHERN INDIANS IN STATE APPROVED SOCIAL STUDIES TEXTBOOKS

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A selected survey of social studies textbooks used in Alabama public school fourth year elementary classes was made to determine the nature and accuracy of the presentation of southern Indian cultures. As a part of the fourth year curriculum, a study of Alabama Indian cultures presenting their role in Alabama's past is normally offered. Textbooks utilized are chosen from a master list of books approved by the Alabama State Textbook Committee.

Certain books surveyed were found to be factually unsubstantiated and grossly inaccurate in the stereotypical account of Indian ethnography.

#### THE MANY VIEWS OF DEPTFORD--A NEED FOR A CLOSER LOOK

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As in the case of Lamar, Swift Creek and certain other cultural complexes seen in southeastern archeology, Deptford, a Middle Woodland entity, is suffering from an acute case of "identity crisis."

Since its earliest definition by Waring and Holder on the banks of the Savannah River in 1937, and subsequent descriptive treatment in text by Caldwell, Sears and others, "Deptford" has become an identification

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tag popularly applied to similar or related cultural manifestations from coastal Georgia to Mississippi and from Florida to the southern Appalachians.

Much of this casual naming is based mainly upon ceramic trait similarities--a justified approach if referring to a "tradition" but certainly not to be employed in defining a "phase."

This paper is designed to point up this as a frequently committed error in taxonomic descriptive procedure and that the widespread usage of the term "Deptford Phase" or the like, is, in effect, without ethnological meaning or significance.

The need, then, is a) To regard and accept "Deptford" as a far ranging tradition involving material culture similarities but reduced geographically to a number of culture units which produced sufficiently disparate artifact assemblages to warrant the designation of "phase" in the taxonomic structure, and b) To identify, for regional purposes, each phase within the Deptford tradition in terms of these artifact variations.

### MORMONISM AND ARCHAEOLOGICAL RESEARCH

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Brigham Young University under the direction of the Mormon Church has established a program in American archaeology with emphasis upon the claims of the Book of Mormon as to the origin and early history of the Ancient civilizations of the New World.

The program started over 30 years ago has produced an archaeology department, a professional association, and a foundation for conducting archaeological research. The foundation which has been officered by nonmormons such as A. V. Kidder, Gordon R. Willey, and Gordon F. Ekholm has established an outstanding reputation for outstanding research, especially in southern and central Mexico. It appears that Brigham Young University will continue to function in this manner in the future.

### THE ANTHROPOMETRIC STUDY OF SITE 1 Au28

Janice Hutchinson  
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University of Alabama, University

This anthropometric study of 1 Au28 was carried out in the Fall of 1976 by the author. Site 1 Au28 is located in the Jones Bluff Reservoir on the Alabama River between Montgomery and Selma, Alabama. The five burials discussed in this paper were identified as Mississippian, based on the shell tempered pottery found in the pit fills. The study

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describes the burials giving the estimated sex, age, and stature of the individuals, also noting any pathologies. A variety of osteometric indices are utilized in order to demonstrate their value. It is concluded that, although the use of indices has fallen into disfavor since the development of multivariate statistics, they should not be totally abandoned since they are useful in studying fragmented skeletal materials.

### REPORT ON THE CONSERVATION AND PRESERVATION OF THE ARTIFACTS FROM 1 Tu 267

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Brooms Archaeological Associates

The emphasis of this paper is to relate the activities of the conservator on the artifacts recovered from a nineteenth century college dormitory that was burned during the Civil War. Discussion of techniques for the removal of lime concretions from ceramics is forwarded. The uses of Sulfuric and Citric acids and mechanical means of cleaning copper alloys and the process of electrochemical reduction, electrolysis and "peening" on iron objects is discussed. A time usage comparison is included.

### MARRIAGE, CHILDREARING, AND THE HOMOSEXUAL SUBCULTURE

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A study of homosexual attitudes toward marriage and childrearing was undertaken. The data were gathered from interviews conducted with approximately fifty males at four gay bars in Mobile and Biloxi. Half the interviews were informal, unstructured, and conversational in nature; the other twenty-five were informal but structured and included the filling out of a questionnaire. Homosexuals prefer to marry members of the same sex, and feel as though they are being discriminated against as well as being refused their constitutional right to the pursuit of happiness. There is a feeling among homosexuals that they will have future political power by which to change some of what they consider to be unjust laws. Homosexuals do wish to raise children and believe very strongly in their ability to be good parents.

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### MEDICINAL PLANT USAGE BY THE TUKUNA INDIANS, AMAZONAS, COLOMBIA

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3636 Combat Crew Training Wing (ATC)  
Maxwell AFB, Montgomery, Alabama

Despite the presence of an outpatient clinic with patent medicines within easy access, the Tukuna Indians living along the Rio Loreto-Yacu in Amazonas, Colombia continue their traditional reliance on plant products for combating sickness. A total of 130 prescriptions involving 84 plant species are used by the Tukuna for a variety of common ailments including diarrhea, rheumatism, intestinal worms, and malaria. A large number of prescriptions are also reportedly used for contraceptives and abortifacients.

### HEAT TREATMENT EFFECT ON CHERT USED FOR PROJECTILE POINTS IN ALABAMA

Pamela M. Pincha  
Department of Anthropology  
The University of Alabama, University  
and  
Marc J. Defant  
Department of Geology and Geography  
The University of Alabama, University

Chert samples were collected from four gravel bar localities along the Tombigbee River, in an area southwest of Aliceville, Pickens County, Alabama. These chert samples bear a strong resemblance to chert found in two nearby Indian localities suggesting that chert of this variety was used by the Indians.

The objectives of this investigation are to: 1) identify the temperature at which chert changes color during heating, 2) if the color change is continuous with increasing temperature, 3) the cause of the color change, 4) show how weight loss is affected by the length of the heating period, and 5) determine if these results can be applied to the identification of preheated chert samples found in archaeological sites.

Chert samples were crushed to one to two gram sizes, weighed, and placed in a preheated furnace. All treated samples were removed between temperature increases, cooled to room temperature in a dessicator, and reweighed. The color was described using a Munsell Rock-Color Chart.

From the data various results become apparent. The amount of weight loss (probably due to CO<sub>2</sub> and H<sub>2</sub>O volitalization) during heating is time dependent but bears no relationship to color changes in the chert. This research suggests that the change in color is the result of iron oxidation. The color change of the specimens analyzed occurs between 250°-300°C. A continuous color change with increasing temperature was not found.



## Abstracts

### EARLY 19TH CENTURY ARTIFACTS FROM FORT STODDERT

Dan L. Jenkins  
Department of Sociology and Anthropology  
University of South Alabama, Mobile

The purpose of this paper is to discuss the artifact assemblage recovered during test excavations at Fort Stoddert. An analysis of this material can help give an insight into the role Alabama river forts played in the southerly expansion of the American "frontier" during the early 1800's.

Considering the chronological position (1799-1828?) the site and the excellent state of artifact preservation, Fort Stoddert may prove to be an invaluable type site for an important period of Alabama history.

### NEOCOLONIAL ATTITUDES REFLECTED IN AFRICAN URBAN STUDIES: OR 'UNDER EVERY AFRICAN THERE IS A PRIMITIVE TRIBESMAN'

Susan Middleton-Keirn  
Jacksonville State University  
Jacksonville, Alabama

Neocolonial attitudes, often insidiously present in research and writing on the subject of urban Africans, can inhibit our understanding of certain segments of this population. Analytical perspectives have centered upon the concept of adaptation--a concept basic to anthropology. In this perspective the adjustments and adaptations made by rural residents as they move into the urban milieu and out again to their rural homes are the focus. Alternately anthropologists have stressed the persistence of varied elements of African tradition in order to present a model that has urban-dwelling Africans portrayed as selectively, situationally, and uncomfortably straddling two worlds.

The contention of this paper is that in dealing with a study of Africans committed to an urban life-style in urban areas there is an important (and often neglected) perspective that could enrich our understanding of social process. This is the perspective of developing forms of social stratification.

Drawing on her own field research in two urban African centers, as well as a brief survey of current literature, the author suggests a combination of specific approaches by which anthropologists can explore social process in an urban-committed population segment.

## Abstracts

### THE BLAKELEY SITE: AN ARCHAEOLOGICAL SURVEY

Richard Fuller  
Department of Sociology and Anthropology  
University of South Alabama

Beginning in February of this year, the University of South Alabama commenced an archaeological investigation of the early 19th century town of Blakeley (1Ba 221). The field work through April has consisted of test pits at selected locations, the excavation of a kiln site (1Ba 221-A), and the partial excavation of a trash pit (1Ba 221-B).

The purpose of this paper is to summarize the field work during this period and to present a representative selection of the artifacts that the site has produced.

By doing cross-site comparisons with other early 19th century sites in the area the archaeological survey of Blakeley may aid in understanding what life was like in the "frontier" Alabama Territory.

### A RESTUDY OF THE ANTHROPOLOGY CURRICULUM AT ALABAMA'S INSTITUTIONS OF HIGHER EDUCATION 1977\*

Margaret Z. Searcy  
The University of Alabama, University

The development of the anthropology curriculum in Alabama's institutions of higher learning can be traced over a thirty year period beginning with the first joint Department of Sociology and Anthropology at The University of Alabama in 1948. The first separate anthropology major was listed in the 1959-1960 Catalogue. In 1967 this Department split creating the State's first Department of Anthropology.

During the early sixties anthropology grew steadily, but only The University of Alabama offered a minor, major and a master's degree in anthropology. In 1968 the Social Science Section of The Alabama Academy of Science split creating Section XI for anthropologists. A survey of the anthropological curriculum at fifty-three Alabama institutions of higher learning revealed that twenty persons at fourteen institutions taught anthropology; five had Ph.D. degrees (only two taught a full schedule); six additional persons had advanced training in anthropology; the remainder were trained in other disciplines.

This year at seventeen of Alabama's four year institutions forty-two persons having specialized training in anthropology are faculty members; twenty-seven have terminal degrees. The number of junior colleges teaching anthropology increased from three to five; an additional three list it. The faculty at junior colleges as a whole lacks advanced anthropological training. The area of real growth has been within the universities with a marked increase in student numbers, course offerings and

## Abstracts

faculty expertise. The University of Alabama still offers the State's only master's degree.

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\* For a chart write: Anthropological Curriculum in Alabama  
Box 6135  
University, Alabama 35486

MINUTES  
ALABAMA ACADEMY OF SCIENCE  
ANNUAL BUSINESS MEETING  
University of Alabama  
Tuscaloosa, Alabama  
April 9, 1977

President Diener called the meeting to order and asked for the secretary's report.

*SECRETARY'S REPORT: Dr. Ken Ottis*

Status of Membership. Our membership has been slipping the last couple of years. There are over 3000 professors, associate professors, assistant professors, and instructors in the state colleges and universities of Alabama. The faculties of our private colleges and universities swell this figure to over 4000. We are not doing the recruiting job that we should be doing. With our present administrative set-up, we could easily handle 200 more members. You do not encourage young staff members to become active in the Academy after they attend a section meeting and see only 6 or 8 people in attendance.

Present Membership:	
New Members	63
Reinstatements	7
Members dropped (address unknown)	51
Members deceased	3
Total membership as of April 5, 1977	667

Motion was made and seconded that the report be accepted. Motion was passed.

*REPORT OF THE TREASURER: Dr. William J. Wingo*  
April 1, 1976 to April 6, 1977

Balance in checking account	4/1/76 =	\$ 6,348.41
Income and/or deposits to	4/6/77 =	7,779.60
		<u>\$14,128.01</u>
Expenses incurred and/or paid	4/1/76-4/6/77 =	\$ 6,720.91
Balance	4/6/77	Checking 7,407.10
		Passbook 4,254.41
	Cert. of Deposit	8,261.61
		<u>\$19,923.12</u>

## Minutes

### Income

Journ. Subsc.	15
Jr. Academy	1300
Dues	5300
Ann. Mtg.	1165
	<u>7780</u>

### Expenses

Pres.	244
Sec.	702
Treas.	206
3 iss. Journal	807
Jr. Academy	1850
Pub. Relations	10
Newsletter	82
Student g & p*	1435
Coord. Off.	300
Printing	1051
Assessment	33
	<u>6720</u>

\* grants and prizes

*REPORT OF COMMITTEE OF PLACE AND DATE OF MEETING: Dr. Jack S. Brown*

1) Dr. Ralph Adams, President, Troy State University has confirmed the invitation to meet at the Montgomery campus. Dr. James Bailey and Dr. James Wilkes have been appointed to coordinate arrangements. Dates will be set later for the 1973 meeting.

2) Contact has been made with Dean Frank McArthur and Executive President Roy Stevens, of the University of North Alabama, in regard to the 1979 meeting. A tentative approval has been given and confirmation is expected in the near future.

3) No invitations have been received for the 1980 meeting.

The motion was made, seconded, and passed that the report be accepted.

*REPORT OF THE RESOLUTION COMMITTEE: Dr. Hoyt Kaylor*

Whereas the Alabama Academy of Science has held its 1977 annual meeting at The University of Alabama, and has enjoyed the hospitality of the University, now therefore

BE IT RESOLVED that the Academy express its gratitude to Dr. David Matthews, President of the University, and to the University for hosting this meeting. To Dr. Billy P. Helms, Chairman of our local hosts, and to the members of his host committee, Dr. James D. Walker and Mr. William Rodgers; to the faculty and staff of the University; and to all of the many others who contributed to the success of this meeting, we, the Academy members, express our appreciation for their efforts on our behalf.

## Minutes

BE IT FURTHER RESOLVED that the Academy express its appreciation to Commander Robert Crippen, USN, and to the Honorable Walter Flowers for their presentations to the Academy and to Mr. John L. Cain and the members of his panel for the excellent symposium on "Science in Public Policy."

BE IT FURTHER RESOLVED that the Academy express its appreciation to those who retire from leadership in the Academy this year, and especially to Dr. Urban L. Diener, President, and Dr. Thomas J. Carrington, Editor of the Journal.

WHEREAS Dr. Charles Feazel has resigned as Secretary-Treasurer of the Gorgas Scholarship Foundation, and

WHEREAS he has been a member of the Board of Trustees of the Foundation since 1963, now therefore

BE IT RESOLVED that the Alabama Academy of Science and the Alabama Junior Academy of Science express their appreciation to Dr. Feazel for the outstanding service he has rendered to the Foundation, to the Academies, and to the furthering of an interest in science among the young people of our state.

WHEREAS The Reverend George O. Twellmeyer, S. J., has rendered his resignation as State Coordinator of Science Fairs for the Academy and

WHEREAS Father Twellmeyer held this office for twenty years, and

WHEREAS he has served the Academies most faithfully and competently during his tenure of office, now therefore,

BE IT RESOLVED that the Alabama Academy of Science and the Alabama Junior Academy of Science express their appreciation to Father Twellmeyer for the dedicated and outstanding service that he has rendered to the Academies and to the Science Fair program.

It is hereby moved by the Committee on Resolutions that the above be accepted and entered in the Minutes of the Academy.

A motion was made, seconded, and passed that the report be accepted.

*REPORT OF THE AUDITORS (SENIOR ACADEMY): Drs. Paul Bailey and Dan Holliman*

April 6, 1977

TO: Chairman  
Executive Committee  
Alabama Academy of Science

FROM: Auditing Committee

RE: Audit 1976-1977

## Minutes

On this date we have examined the records of the Treasurer of the Alabama Academy of Science and have found them to be in order.

The motion was made, seconded, and passed that the Auditor's report be accepted.

*REPORT OF THE RESEARCH COMMITTEE: Dr. Jack Moore*

No papers were presented in competition for the Student Research Awards this year. The Committee asks all members of the Academy to encourage students to enter this competition in the future.

Two Student Research Grants were awarded:

1. Deborah K. Hicks, U. of Ala., Tuscaloosa was awarded \$230.00 for the reserach proposal entitled: Ethnographic Study of an Alabama Indian Community.
2. Duane F. Chapman, U. of Ala., Tuscaloosa was awarded \$200.00 for the research proposal entitled: Case Study of a Migrant Family in Baldwin County.

A motion was made, seconded, and passed that the report be accepted.

*REPORT OF THE NOMINATING COMMITTEE: Dr. Reuban Boozer*

The Nominating Committee of the Alabama Academy of Science respectfully submits the following members of the Academy for nomination to serve specified offices of the Academy:

*President Elect:* William F. Arendale, UAH  
*Editor of the Journal:* William H. Mason, AU  
*Counselor of the AAAS:* H. A. Henderson, TVA  
*Counselor of the Junior Academy:* James D. Welker, UAT  
*Coordinator of Science Fairs:* Rosemary Crawford, Spring Hill College  
*Board of Trustees:* Wayne F. Finley, UAB  
John H. McKibbin, UAB  
Harry M. Philpott, AU  
James F. Sulzby

A motion was amde that the above nominations be accepted and that they be elected by acclamation. The motion was seconded and passed.

*REPORT OF THE CHAIRMAN FOR REGIONAL SCIENCE FAIRS: Mrs. Rosemary Crawford, Secretary. Report was read by Betty Bigham.*

All seven of the Regional Fairs of Alabama have operated successful Fairs this year. Six of them hold contracts with Science Service and will send Finalists to the International Science & Engineering Fair in Cleveland, Ohio May 9-14.

Students representing their regions are:

Central Region

Miss Becky Ann Reitenour  
Mr. Marvin M. Smith



## Minutes

Mobile Region	Miss Karen Duke
Eastern Region	Miss Melanie Gardner Mr. Butch Clothioux
North Region	Miss Janine Askins Mr. William O. Wear
Northeastern Region	Mr. Paul W. Lightsey Mr. Wesley D. Tarvin
Western Region	Mr. Steve Odewahn Mr. Glenn Stokes
South Region	(Winners not reported)

Motion was made, seconded, and passed that the report be accepted.

*REPORT OF THE GORGAS SCHOLARSHIP FOUNDATION: L. S. Hazelgrove. Report was read by W. P. Rodgers.*

The Gorgas Scholarship Foundation announced today that it has selected the winner and alternates from the finalists in the 1977 Alabama Science Talent Search. The Search was held at the meeting of the Alabama Academy of Science at the University of Alabama. The winner of the cash award is Butler Preston Hine, III, 1208 27th Avenue, East, Tuscaloosa, Alabama from Tuscaloosa High School. His teacher is Robert W. Cleere. Alternates are: 1) Akshay Kumar Bajaj, 347 West Vanderbilt Loop, Montgomery, Alabama from Robert E. Lee High School. His teacher is Frank R. Johnson. 2) Thomas McWhorter Smith, 1202 Linda Street, Andalusia, Alabama from Andalusia High School. His teacher is Lawrence DeFillipi. 3) John Lemoyne Castle, 4018 Heatherhill Road, Huntsville, Alabama from the Randolph School. His teacher is William T. Smathers, Jr. 4) Alexander Collins Brown, 984 Neal Street, Tuskegee Institute High School. His teacher is Harriett W. Jeffeies. 5) George Benjamin Ackley, 904 Betty Street, S.W., Decatur, Alabama from Austin High School. His teacher is Dan Whitson. 6) James Haywood Graddy, P.O. Box 234, Cottonwood, Alabama from Cottonwood High School. His teacher is Phyllis E. Walch. 7) Katherine Denise Stringer, Route one, Ashford, Alabama from Cottonwood High School. Her teacher is Phyllis E. Walch. 8) Michael Wayne Grier, Route three, Box 282, Montgomery, Alabama from Robert E. Lee High School. His teacher is Brenda Garrigan.

The finalists for the Gorgas Foundation competition were selected on the basis of their high school records and their entries in the National Science Talent Search from the Westinhhouse Science Scholarship and Awards, administered by Science Service. Mr. Ackley, Mr. Bajaj, Mr. Graddy, Mr. Grier, and Ms. Stringer were named to the honors group in the national competition. Winners and alternates in the Gorgas contest receive offers of tuition scholarships to colleges and universities in Alabama for the study of science. The Gorgas Foundation is named for General William Crawford Gorgas, the Alabama physician who conquered yellow fever in the Panama Canal Zone while serving as Surgeon General in the U.S. Army.

## Minutes

The purposes of the Foundation are to promote interest in science and to aid in the education of promising students.

The motion was made, seconded, and passed that the report be accepted.

### *ANNUAL REPORT OF JUNIOR ACADEMY OF SCIENCE: James Welker*

The JSHS Paper Competition was held in Birmingham on the campus of UAB, Saturday, February 19, 1977. The following papers were presented, with the winners being students identified with asterisks:

#### *BIOLOGICAL SCIENCES*

1. Ricky Bajas, "Observations and Studies of the Isoleucine-Valine Gene From *Escherichia coli*"
2. Richard Conn, "Germination: One of the Many Wonders of the World"
- \*3. Kathryn Dollison, "Tissue Culture of Phaleonopsis Orchids"
- \*4. Stephen Heimborg, "Comparison of Physical and Biological Solar Cells"
5. Pam Palmer, "The Amount of Protein in Rat Liver with Chronic Use of Ethanol"
6. Marvin Smith, "Research in Plant Cancer"
7. Thomas Smith, "The Effect Fluorides Have on the Growth of *Staphylococcus aureus*"
8. Richard Torkington, "Color Sensitivity Response of the Human Eye During Dark Adaptation"
9. Cynthia Washington, "The Effects of Monocrotophos and Acephate on Seed Germination"

#### *HUMANITIES*

1. Gerrie Chunn, "Boy Named Sue; Girl Named Gerrie"
2. Cassandra Evans, "Drinking Water: Is It Too Clean Or Not Clean Enough"
3. Robin Giles, "Cosmetics: The Need For Control"
- \*4. Nancy Granberry, "Can Genetic Laterality Be Suppressed By the Environment?"
5. Pam Lester, "Human Genetic Engineering"
6. Jimmy Mayo, "Guru-Group Isolation: Implications of Isolated Group"
7. Barry Moody, "Why Ban Chloroform?"
8. Cindy Nunnelle, "Recycling"
9. Cynthia Pryor, "An Evaluation of the Sub-Conscious as It Relates to Human Socialistic Behavior as Opposed to Life After Death"

#### *MATHEMATICS AND ENGINEERING*

1. Karen Clecker, "Analysis of Population Patterns"
- \*2. Michael Hauck, "Graphic Multiplication and Division with 0 and -1 Defined as Operations"
3. Butler Hine III, "A Low-Cost Radio Telescope for Amateur Use"
4. Yolanda Humphrey, "Dimensional Analysis: Problems in Physics"
- \*5. Amy Morris, "The Generation and Analysis of Alterations of the Snowflake Curve"

## Minutes

6. Carl Powe, "Holography Applied to Mass Data Storage"
7. Martin Rogers, "The Effects of Tilting the Probability Curve"
8. Lee Shackelford, "Using the Desert Sun for World Power"
9. Lynda Ward, "Principles of Flight Demonstrated by the Use of a Model"

### PHYSICAL SCIENCE

1. Caroline Anderson, "Hidden Dangers in Food"
2. Tim Booter, "Can We Analyze More Inorganic Compounds Qualitatively and Quantitatively by Using Chromatography?"
3. Michael Brett, "The Investigation of Dimethylmercury in Fish *Phoxinus phoxinus*"
4. Alex Brown, "Action Photography With a Fast and Slow Film"
5. Terissa Certain, "The Effects of Temperature on Graphical Recordings of Sound Wave Forms"
6. James H. Graddy, "Effect of Preparation Variation on Variability of Dyeings on Cotton Fabrics"
7. Eugene Knight, "Epinephrine"
8. Charles Mathews, "Fission and Fusion: The Answer to Today's Confusion"
- \*9. Stephen Odewahn, "The Observation and Analysis of Stellar Spectra"

All of the winners of the paper competition, with the exception of Stephen Odewahn, will attend the National JSHS to be held at West Point Academy, May 4-7, 1977. Stephen Odewahn, who also attended the National JSHS in 1976, chose this year to visit the Bell Laboratories at Murray Hill, New Jersey, as guest of the Bell Telephone Company. Steve will be accompanied by his teacher, Mr. Robert Cleere, Tuscaloosa High School.

Michael Hauck was selected by the judges of the paper competition to present his paper at the National JSHS. As the representative from Alabama, he will compete for an opportunity to participate in the International Youth Science Fortnight, July 27-August 10, 1977.

Eighty science clubs are represented at the Annual Meeting in Tuscaloosa, with more than 300 students and teachers participating. Three new clubs are attending this year's meeting for the first time: Litchfield High School (Gadsden), West End Christian School (Tuscaloosa), and Sumter County High School (York).

Childersburg High School had the largest group in attendance with 28 students, Cottonwood had 26, and Bradshaw had 22.

Speakers for the 1977 meeting were: Dr. Sarah L. Light, Assistant Professor of Business Office Education, University of Alabama, who spoke on the topic "Come With Me on a Journey Into Creativity," and Astronaut Robert Crippen, Johnson Space Flight Center, Houston, who spoke on the topic "The Future in Space Exploration."

The following persons received awards:

Outstanding Teacher with more than five years of experience--Mrs. Loyce Whitson, Winston County High School, Double Springs.

## Minutes

Outstanding Teacher with less than five years experience--Mr. George Gorey, Jr., Donoho School, Anniston

Student Research Grants: Amy Morris, Childersburg, \$150; Charles Barnett, Phillips High School, Bear Creek; Debra Barnett, Bradshaw, \$80. These awards are dependent on arrival of special research funds from AAAS.

Henry Walker Memorial Scholarship--Patrick Wayne Mardis, Ramsey H.S., Birmingham, \$500.

AAAS Subscription Awards--Gene Knight, The Donoho School, Anniston; Yolanda Foster, Ramsey H.S., Birmingham.

Officers for 1977-78 are:

President: Cliff Hindma, Childersburg High School  
Vice-President: Rex Wright, Randolph School, Huntsville  
Secretary: Ann Waldrup, Robert E. Lee, Montgomery  
Treasurer: Canh Viet Le, Tuskegee Institute High School

*REPORT FROM THE SECTIONS: (Temure temination date after the name)*

I. *Biological Science: Carl Dixon*

Section 1-A	Morning--12 papers	Afternoon--10 papers
	Attendance--20	Attendance--21
Section 2-B	Morning--13 papers	Afternoon--10 papers
	Attendance--15	Attendance--25

Elections: Chairman, Dr. Margaret Miller (1979), USA; Vice-Chairman, Dr. Curt Peterson (1979), AU.

II. *Chemistry: T. G. Jackson*

Morning Session--2 scientific lectures & discussion

Afternoon Session--2 scientific lectures & discussion

Elections: Chairman, Dr. Bill Paudler (1979), UAT; Vice-Chairman, Dr. Cox (1979), JSU.

III. *Geology: Robert Cook*

Morning Session--8 papers

Afternoon--11 papers

Attendance--30

Attendance--37

Elections: Chairman, George F. Brockman (1979), UAB; Vice-Chairman, Denny N. Bearce (1979), UAB.

IV. *Forestry, Geography & Conservation: Eugene Wilson*

Morning Session--7 papers

Afternoon--7 papers

Attendance--28

Attendance 25

Elections: Chairman, Euguen Wilson (1978), USA; Vice-Chairman, Howard Johnson (1978), JSU.

V. *Physics and Mathematics: Bill Alford*

Morning Session--7 papers

Afternoon--7 papers

Attendance--23

Attendance--25

## Minutes

Elections: Chairman, Dr. Bill Alford (1978), AU; Vice-Chairman, Dr. Aldo Forte (1978), UAH.

VI. *Industry and Economics: Wayne Lacy*

Morning Session--9 papers      Afternoon--5 papers

Attendance--16      Attendance--16

Elections: Chairman, Wayne Lacy (1978), AUM; Vice-Chairman, Billy J. Bond (1978), TVA.

VII. *Science Education: Dan Whitson*

Morning Session--8 papers      Afternoon--No session

Attendance--30

Elections: Chairman, Dan Whitson (1978), Decatur; Vice-Chairman, Gordon Bliss (1978), Ala. State U.

VIII. *Social Science: Charles Summersell*

Morning Session (Friday)--3 papers      Afternoon Session--3 papers

Attendance--9      Attendance--4

Morning Session (Saturday)--3 papers

Attendance--5

Elections: Chairman, Henry Marks (1979), UAH; Vice-Chairman, Glen Eaves (1979), AU.

IX. *Health Science: George Hand*

Morning Session--9 papers      Afternoon--11 papers

Attendance--23      Attendance--20

Elections: Chairman, Dr. Charles Baugh (1979), USA; Vice-Chairman, Dr. Richard Shoemaker (1979), UAB.

X. *Engineering: Reynolds Shotts*

Morning Session--6 papers      Afternoon--4 papers

Attendance--5      Attendance--6

Elections: Chairman, Walker H. Land (1979), I.B.M.; Vice-Chairman, Harold L. Pastrick (1979), Redstone Arsenal

XI. *Anthropology: Avery Church*

Morning Session--7 papers      Afternoon--6 papers

Attendance--19      Attendance--17

Elections: Chairman, Dr. Robert J. Fornaro (1979), USA; Vice-Chairman, Dr. John A. Wallthal (1979), UAT.

### REPORT OF THE PRESIDENT:

The President thanked the Secretary and the Treasurer for the help that he had received during his administration. The Secretary would like to add that he, the Secretary, received more help than he gave. The President also thanked all of the officers of the Academy for their cooperation during the year.

### OLD BUSINESS: President Diener

The President reviewed the proposed changes in the Constitution and by-laws. These changes have been presented to the Executive Committee where

## Minutes

they were discussed most fully. The Executive Committee gave its approval to the changes and asked that they be presented to the Academy assembled. The changes are noted, in detail, in the minutes of the Executive Committee meeting.

### *MOTIONS:*

Jack Moore moved and Emmet Carmichael seconded a motion that the changes in the Constitution be made as suggested. The motion was passed.

Wayne Lacy moved, Robert Gudauskas seconded a motion that the changes in the Bylaws be made as suggested. The motion was passed.

The Secretary read a Resolution tendered by the Medical Science Section requesting that the Section change its name to Health Sciences. Bill Wingo moved and Danice Costes seconded the motion that the section name change be allowed. The motion was passed.

### *CHAIRMAN OF THE NOMINATING COMMITTEE: Rueben Boozer*

Since the constitutional changes call for a second Vice-President, he would like to place in nomination for that office the name of Jack Moore. A motion was then made that the nomination be accepted and that Jack Moore be elected Second Vice-President by acclamation. The motion was seconded and passed.

President Diener then introduced the new president for the coming year, Dr. James Wilkes of Troy State University. Dr. Wilkes complimented Dr. Diener for the many things he had accomplished during his tenure.

Dr. Wilkes adjourned the meeting at 12:00 p.m.

CONSTITUTION AND BY-LAWS  
OF THE  
ALABAMA ACADEMY OF SCIENCE

(as amended April 9, 1977)

Adopted in 1924 (1), amended (2-5,7-10), published in journal (1,2,3,6).

STATE OF ALABAMA)

ss.

JEFFERSON COUNTY)

KNOW ALL MEN BY THESE PRESENTS: That we, the undersigned constituting trustees of Alabama Academy of Science, an association heretofore unincorporated, desiring to become incorporated under the provisions of Title 10 of the 1940 Code of Alabama, do hereby file this declaration in writing, and state:

ARTICLE I. *NAME*

The name of this corporation shall be Alabama Academy of Science.

ARTICLE II. *OBJECTS*

The objects for which the corporation is formed are:

1. To promote the development of interest in scientific matters in the State of Alabama;
2. To provide means for publication of scientific papers and abstracts;
3. To provide opportunity for increased cooperation and fellowship among its members;
4. To cooperate with other organizations having similar aims;
5. To render public service in scientific matters;
6. To promote the interest in and study of science by the youth of Alabama;
7. To provide for and award scholarships to deserving youths in Alabama;
8. The Alabama Academy of Science shall not have any capital stock, shall not pursue any of its objects or purposes for pecuniary profit to any of its members, and no part of its net receipts shall inure to the benefit of any private shareholder or individual.



## Constitution and By-Laws

### ARTICLE III. *LOCATION*

The office of the Academy shall be in Birmingham, Jefferson County, Alabama.

### ARTICLE IV. *POWERS*

In furtherance, but not in limitation, of the powers conferred by statute, the Academy shall have power:

1. To charge an initiation fee and membership dues to provide income sufficient to meet the needs of its activities;
2. To acquire and hold real property and personal property, stocks in business corporations, bonds and other evidences of indebtedness, to receive property by gift, will, or device, and to hold the same in conformity with all lawful conditions imposed by the donor; to sell, lease or otherwise alienate its property and to exercise such other powers as are incident to private corporations, but not for the pecuniary gain of any member.
3. To borrow money and to secure the payment thereof by mortgage or deed of trust on all or any part of its property, real or personal or both;
4. To apply for, obtain, register, purchase, lease or otherwise to acquire, and to hold, use, own, operate and introduce, and sell assign, or otherwise to dispose of, any trademarks, trade names, patents, inventions, improvements and processes used in connection with or secured under letters patent of the United States, or elsewhere; and to use, exercise, develop, grant licenses in respect of, or otherwise turn to account any such trade-marks, patents, licenses, processes and the like, or any property or rights.

### ARTICLE V. *TRUSTEES*

The names, post office addresses, and terms of office of the founding trustees are as follows:

NAME	ADDRESS	TERM
Henry L. Jennings	Title Guarantee Building, Birmingham	3 yrs.
Arthur T. McWane	McWane Cast Iron Pipe Company, Birmingham	3 yrs.
Carl B. Fritsche	Reichold Chemical Company, Tuscaloosa	2 yrs.
George R. Stuart	Birmingham-Southern College, Birmingham	2 yrs.
Harwell G. Davis	Howard College, Birmingham	1 yr.
James L. Kassner	University, Alabama	1 yr.

The names, post office addresses, and terms of office of the present trustees are as follows:

## Constitution and By-Laws

NAME	ADDRESS	TERM EXPIRES
Samuel B. Barker	University of Alabama, Birmingham	1978
Elroy A. Curl	Auburn University, Auburn	1978
H. A. Henderson	TVA, Muscle Shoals	1978
Joseph C. Thomas	University of North Alabama, Florence	1978
William J. Barrett	Southern Research Institute, Birmingham	1979
Emmett Carmichael	University of Alabama, Birmingham	1979
Howard E. Carr	Auburn University, Auburn	1979
G. O. Spencer	Rt. 2, Box 426, Harvest	1979
Wayne H. Finley	University of Alabama, Birmingham	1980
John H. McKibbin	University of Alabama, Birmingham	1980
Harry M. Philpott	Auburn University, Auburn	1980
James F. Sulzby	3121 Carlisle Road, Birmingham	1980

### ARTICLE VI. *MEMBERS*

1. All members of the Alabama Academy of Science in good standing shall become members of the Corporation, and different classes of membership together with the rights and privileges of each class shall be determined by the By-Laws of the Corporation.
2. There shall be no personal, individual or other liability whatsoever on the part of any member of the Academy, either for the debts of the Academy or for any act or omission of the Academy or of any officer, agent or employee thereof.

### ARTICLE VII. *MEETINGS OF THE MEMBERSHIP*

1. There shall be an annual meeting of the members of the Academy, the time and place to be determined by the Executive Committee at least twenty days in advance;
2. Special meetings of the membership may be called by the President and he shall call such meetings on the written request of ten (10) active members;
3. Notice of all meetings of the members shall be in writing mailed to the last known address at least ten (10) days in advance of such meeting. The members present at any such meeting shall constitute a quorum for the transaction of business;
4. The rights of members to vote at meetings of the membership shall be determined by the By-Laws.

## Constitution and By-Laws

### ARTICLE VIII. *OFFICERS*

1. The officers of the Academy shall be elected by the membership and shall be twelve trustees, a president, a first vice-president (president-elect), a second vice-president, chairmen for the various sections, vice-chairmen for the various sections, a secretary, a treasurer, a councilor of the American Association for the Advancement of Science, an editor of the Journal, three counselors of the Junior Academy, and a coordinator of Regional Science Fairs.
2. At the close of each annual meeting, the first vice-president (president-elect) shall become President of the Academy. A new first vice-president (president-elect), a second vice-president, and other officers to fill all other offices becoming vacant following the current annual meeting shall be elected by a plurality of the votes of the members present at said meeting and their terms of office shall begin at the close of the meeting.
3. The tenure of office shall be one year or until successors shall be elected, except that the section Chairmen and Vice-chairmen shall serve two years and the Trustees, the Secretary, the Treasurer, the Councilor of the American Association for the Advancement of Science, the Editor of the Journal, the Coordinator of Regional Science Fairs, and the three Counselors of the Junior Academy, one of whom shall be elected each year to replace one whose term is expiring, shall serve three years and shall be selected triennially.
4. The affairs of the Academy shall be managed by an Executive Committee which shall be composed of the elected officers together with all active past Presidents and the Chairmen of standing committees authorized by the By-Laws.
5. The Executive Committee shall have the power to make and alter the By-Laws of the Academy; to hold meetings at such places and at such times as shall from time to time be designated by the By-Laws or by resolution of the committee; to fix the amount of fees and dues to be collected from members and shall have such other powers, not inconsistent herewith as may be necessary to carry out the purposes of the Academy. The By-Laws may prescribe the number of members of the committee necessary to constitute a quorum which number may be less than a majority of the whole number of the members.
6. Vacancies on the Executive Committee that occur between annual meetings shall be filled in the following manner: If the office of President shall become vacant, the first vice-president (president-elect) shall become President. If the office of first vice-president (president-elect) shall become vacant, the office shall be filled by the second vice-president. Vacancies in any other offices of the Academy shall be filled by the Executive Committee convened on call of the President or, if necessary, by the Secretary.
7. At the first business session of the Executive Committee, the President shall name a Nominating Committee to nominate officers of the Academy, including the Vice-Chairmen. Each Section will suggest a nominee for Vice-Chairman.
8. The Trustees shall be ex-officio members of the committee on finance for the Academy and shall take and hold title to all real property of the Corporation and shall act as custodians of all money and personal property of whatsoever kind except membership fees and

## Constitution and By-Laws

dues, acquired by the Academy for purposes other than the general operating expenses thereof, in trust for the Academy, and shall disburse such money, dispose of such property, borrow money for such purposes other than the operating expenses of the Academy and make and issue notes, bills, bonds, and other evidences of indebtedness and convey by mortgage or deed of trust all or any part of the property owned, real or personal or both, by the Corporation, to secure the payment of any debts contracted by the authority of the Executive Committee; but before such mortgage or deed of trust can be executed, the majority of the Executive Committee shall have first authorized the incurring of the debt and the execution of such mortgage or deed of trust on all or part of the real or personal property, or both of the Corporation, which authorization must be made at a regular meeting or at a special meeting of the Executive Committee specifically called for the purpose. And the Executive Committee at any regular meeting, or at any special meeting called for that purpose, may grant authority to the board of Trustees to convey by mortgage or deed of trust any or all of its property, real or personal, it may then own or thereafter acquire, for the purpose of securing any debts contracted by the Trustees for the Corporation.

9. The Trustees shall serve for a term of three (3) years, unless specifically elected for a lesser term, except that one-third of the Trustees first elected shall be elected to serve for one year, one-third for two years, and one-third for three years, respectively.
10. In case of any increases in the number of Trustees, the additional Trustees shall be elected as may be provided in the By-Laws and one-third of their number shall be elected to serve for one year, one-third for two years, and one-third for three years.
11. In case of any vacancy in any class of Trustee through death, resignation, disqualification or other cause, the Executive Committee, at any regular meeting, or any special meeting called for that purpose, by affirmative vote of the majority of the Committee present, may elect a successor to hold office for the unexpired term.

### ARTICLE IX. *DURATION*

The duration of the Corporation shall be perpetual.

### ARTICLE X. *AMENDMENTS*

This certificate may be amended at any annual meeting by a three-fourths vote of the attending members.

IN WITNESS WHEREOF, this certificate has been executed by the Trustees of the Corporation, acknowledged as required by Law, and offered for record in the Office of the Judge of Probate of Jefferson County, Alabama, this \_\_\_\_\_ day of \_\_\_\_\_, 1977.

## Constitution and By-Laws

Trustee

Address

Sworn and subscribed to before me this  
day of , 1977.

SEAL

Notary Public

Trustee

Address

Sworn and subscribed to before me this  
day of \_\_\_\_\_, 1977.

SEAL

\_\_\_\_\_  
Notary Public

Trustee

Address

Sworn and subscribed to before me this  
day of \_\_\_\_\_, 1977.

SEAL

Notary Public

Trustee

Address

Sworn and subscribed to before me this  
day of \_\_\_\_\_, 1977.

SEAL

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Trustee

Address

Sworn and subscribed to before me this  
day of \_\_\_\_\_, 1977.

## Constitution and By-Laws

SEAL

\_\_\_\_\_  
Notary Public

\_\_\_\_\_  
Trustee

\_\_\_\_\_  
Address

Sworn and subscribed to before me this  
\_\_\_\_\_ day of \_\_\_\_\_, 1977.

SEAL

\_\_\_\_\_  
Notary Public

### BY-LAWS OF THE ALABAMA ACADEMY OF SCIENCE

#### ARTICLE I. *MEMBERSHIP CLASSIFICATION*

Sec. 1. The membership of the Academy shall consist of the following classes:

a) *Member*: Full membership in the Academy shall be open to any adult person in the state of Alabama and other states, who is actively engaged in teaching, research, or other professional activity in pure and applied science. Persons working in industry, economics, science education, and social sciences shall also be eligible for full membership in the Academy.

b) *Collegiate Member*: Any person interested in the promotion of science in Alabama who is registered as a student in a college or university may qualify as a collegiate member for a maximum of five years.

c) *Emeritus Member*: Full members upon formal retirement and after at least twenty (20) years of active membership in the Alabama Academy or other state academy, may upon application to the secretary, have their status changed to Emeritus member with full voting and office holding privileges.

d) *Honorary Member*: Members of the Academy who have received outstanding recognition beyond the State of Alabama shall be eligible for honorary membership. Not more than two honorary members shall be elected in any one year.

e) *Life Member*: Any member of the Academy may become a life member by paying into the treasury at one time the amount established in Article II. (e).

f) *Fellow*: Members of the Academy who are Fellows of the American Association for the Advancement of Science shall be classed as Fellows of the Academy.

## Constitution and By-Laws

g) *Complimentary Member*: High school science clubs are classed as complimentary members. The counselor of the Junior Academy shall certify to the Secretary of the Academy by January 1 of each year those clubs entitled to such membership.

h) *Institutional Member*: Any educational institution in Alabama may become an institutional member.

i) *Sustaining Member*: Any individual, corporation, or organization may become a sustaining member of the Academy. Each corporate or organizational sustaining member is entitled to designate two individuals from its organization to represent it as active members in the proceedings of the Academy.

Sec. 2. Collegiate Members shall not hold office nor vote. Members not residing in Alabama may not hold elective offices, but may serve on committees of the Academy.

Sec. 3. The membership year and the fiscal year shall correspond to the calendar year.

a) New members joining October 1 or thereafter shall be new members as of January 1 the following year.

Sec. 4. Each nomination for membership must be endorsed by a dues-paid member who is in good standing in the Academy. Payment of the required dues and determination by the Secretary that the application meets the requirements for one of the classes of membership set out in Sec. 1. above shall constitute admission to membership.

### ARTICLE II. DUES

Sec. 1. The dues for the several classes of membership shall be as follows:

a) *Member*: Ten Dollars (\$10.00) per annum.

b) *Collegiate Member*: Five Dollars (\$5.00) per annum.

c) *Emeritus Member*: Five Dollars (\$5.00) per annum.

d) *Honorary Member*: None.

e) *Life Member*: Two Hundred Dollars (\$200.00).

f) *Fellow*: Ten Dollars (\$10.00) per annum.

g) *Complimentary Member*: None.

h) *Institutional Member*: High Schools, Ten Dollars (\$10.00) or more, per annum; Junior Colleges, Twenty Dollars (\$20.00) or more, per annum;



## Constitution and By-Laws

Four-year Colleges and Universities, Fifty Dollars (\$50.00) or more, per annum.

i) *Sustaining Member*: Individual, Twenty-five Dollars (\$25.00) or more, per annum. Corporations and Organizations, One Hundred Dollars (\$100.00) or more, per annum.

Sec. 2. No one shall be eligible for office who is in arrears in the payment of dues.

Sec. 3. Members in arrears with their dues as of May 1 shall be dropped from membership.

### ARTICLE III. SECTIONS

Sec. 1. The Academy shall have the following scientific sections:

- I. Biological Sciences
- II. Chemistry
- III. Geology
- IV. Forestry, Geography, and Conservation
- V. Physics and Mathematics
- VI. Industry and Economics
- VII. Science Education
- VIII. Social Sciences
- IX. Health Sciences
- X. Engineering
- XI. Anthropology

### ARTICLE IV. COMMITTEES

Sec. 1. Standing committees of the Academy shall be set up as indicated below and serve for the terms and purposes stated.

a) *Steering Committee*: The Steering Committee shall consist of the President, Immediate Past President, First and Second Vice-Presidents, Secretary, and Treasurer. The Steering Committee is authorized to handle routine jobs of the Academy which shall arise between Executive Committee meetings. It is responsible to the Executive Committee and is not authorized to make decisions for the Academy.

b) *Committee on Membership*: This committee consists of the Vice-Chairmen of the sections and a chairman appointed by the President-Elect. The chairman will serve a one-year term but may be reappointed to successive terms until he has served three years. The committee shall also include such other persons as the chairman deems necessary to provide. The committee shall, through its statewide membership, seek to secure new members, solicit contributing memberships, and handle such investigations and projects as may be assigned to it by the officers or committees of the Academy.

c) *Committee on Research*: The President-Elect shall appoint one member to this committee of five (5) by the annual meeting and the President

## Constitution and By-Laws

shall fill other vacancies as they occur. Terms shall be staggered and for five (5) years. The Chairman will serve a one-year term, but may be reappointed to successive terms until he has served three years. He must have served previously on this committee. The committee shall encourage scientific research in Alabama by whomsoever initiated and conducted, investigate possible sources of funds to be awarded by the Academy to research scientists, and make recommendations on the placing of such funds for the greatest benefit to science. The committee shall recommend any awards and the nature of each recognizing scientific accomplishments by high school students, college undergraduate, graduate students, and research scientists. Any funds awarded shall be expended directly for the purposes designated by a member of the Academy at the institution and/or department receiving the grant.

d) *Committee on Long-Range Planning:* The committee shall consist of four past presidents of the Academy, serving staggered terms of four years each, and shall be designated by the President-Elect. The committee shall elect its chairman who shall serve a one-year term. The committee shall respond to any and all assignments referred to it by the President or the Executive Committee and shall make recommendations in the best interest of the Academy. The Committee may also originate recommendations to the Executive Committee on matters considered of significance to the Academy.

e) *Auditing Committee:* The President-Elect shall appoint annually two auditing committees of two members each, one for the Senior Academy and one for the Junior Academy. The committee shall examine and report to the Academy upon the financial records of the Treasurer of the Academy and the Treasurer of the Junior Academy, respectively, at the meeting for which they were appointed.

f) *Editorial Board:* The Editorial Board shall consist of three members serving staggered terms of three years each, and the annual vacancy shall be filled by appointment by the President-Elect. The Editor of the Journal is an additional ex-officio member of the Board. The Editorial Board shall concern itself with broad editorial policies and with problems of finance and shall act in a general advisory capacity to the Editor of the Journal. The Chairman of the Editorial Board, appointed for three years, shall be responsible for all matters pertaining to institutional subscriptions and exchanges for the journal with the approval of the Executive Committee.

g) *Committee on Junior Academy:* This committee shall consist of the counselors of the several regions, the state officers of the Junior Academy of Science, the sponsors of the state officers of the Junior Academy, and the three counselors elected by the Alabama Academy of Science. The duties of this committee shall be to coordinate the activities of the several regions of the Junior Academy in cooperation with the Coordinator of Regional Science Fairs, to promote the organization of chapters and by all possible means promote the welfare of the chapters, the regions and the entire Junior Academy.

## Constitution and By-Laws

h) *Committee on Place and Date of Meeting:* The President-Elect shall appoint one member to this committee of five (5) prior to taking office and the President shall fill other vacancies as they occur. Terms shall be staggered and for five (5) years. The chairman will serve a one-year term, but may be reappointed to successive terms until he has served three years, and must have served previously on the committee. The committee will make recommendations at the annual business meeting concerning the time and place for holding subsequent annual meetings.

i) *Committee on Local Arrangements:* In consultation with the administration of the host institution, the President shall appoint a Local Arrangements Chairman. The Local Arrangements Chairman shall appoint sub-chairmen for the Senior and Junior arrangements and each subchairman will select the other members of his subcommittee. He is responsible for providing for the physical needs of the Academy at its annual meeting. He shall work closely with the President and the Secretary of the Academy as well as with his subchairmen.

j) *Committee on Newsletter:* The President-Elect shall appoint a Chairman of the Newsletter Committee. The chairman, in consultation with the President, shall select the members of his committee. The chairman will serve a one-year term but may be reappointed to successive terms until he has served three years. The Committee on the Newsletter shall prepare and forward to the members a Newsletter. The Newsletter shall be published at regular intervals determined by the President and chairman of the committee. The Chairman of the Committee on the Newsletter shall act as Editor of the Newsletter.

k) *Committee on Public Relations:* This committee shall be appointed by the President-Elect. The chairman shall serve a one-year term but may be reappointed until he has served three years. This committee shall seek adequate publicity for the meetings and work of the Academy.

l) *Committee on Archives:* The President-Elect shall appoint a Chairman of the Committee on Archives who shall be the Archivist. The Archivist shall keep in a safe place the Archives of the Academy consisting of back numbers of the Journal, exchange publications, and records of the Academy.

m) *Committee on Regional Science Fairs:* This committee shall consist of the State Coordinator of Science Fairs and Regional Coordinators of the several regions. The committee shall coordinate the activities of the Regional Science Fairs in cooperation with the counselors of the Junior Academy of Science.

n) *Committee on Science and Society of the Alabama Academy of Science:* This committee shall have a two-fold function: (1) to make scientific advice available to personnel at all levels of government in Alabama, and (2) to disseminate scientific information to the people of the State. The chairman shall be appointed by the President-Elect for a one-year term, shall be eligible for reappointment, and shall be responsible for seeing that the committee functions.

## Constitution and By-Laws

### ARTICLE V. *DUTIES OF OFFICERS*

Sec. 1. *Trustees*: The duties of the trustees are as enumerated in the Certificate of Incorporation. They shall have the right to hold meetings, both regular and special, at such times and places as may be convenient; and at such meetings a majority of the trustees shall constitute a quorum for the transaction of any business which may come before them.

a) All funds of the Academy which may come into the custody of the trustees shall be carried in a separate bank account in the name of the Academy. The trustees may designate one or more of their number to sign checks drawn to such account.

Sec. 2. *Executive Committee*: The duties of the Executive Committee are set forth in the Constitution.

a) The Executive Committee shall meet at least twice annually. One meeting shall be called by the President in the fall. One meeting shall be immediately before the annual meeting of the Academy. The Executive Committee shall consider at these meetings such business as may properly be brought before it and shall make recommendations for action by the business sessions of the entire Academy.

b) Special meetings of the Executive Committee may be held whenever called by a majority of the members thereof, or by the President. Timely notice of a meeting stating the time and place thereof and indicating briefly the object thereof shall be given the members of the committee by mail, by publication, or by other suitable means whereby the notice may be conveyed. At all meetings of the Executive Committee, regular or special, the members shall constitute a quorum for the transaction of any business which may come before it.

Sec. 3. *President*: The President shall preside at the sessions of the Academy as a whole, and of the Executive Committee.

a) The President shall appoint members to fill vacancies on all committees except as otherwise herein provided.

b) The President shall obtain an appropriate speaker to address the annual banquet. He will share this responsibility with the Counselor of the Junior Academy in alternate years, with the approval of and invitation to the speaker coming from the President of the Academy.

c) The President and Secretary shall make a site visit to the host institution to evaluate facilities for the annual meeting with the Local Arrangements Chairman at least 30 days prior to the Fall meeting of the Executive Committee. A report shall be made at this meeting.

Sec. 4. *First Vice-President (President-Elect)*: During his tenure the First Vice-President shall select chairmen and members to all committees provided herein. They shall be appointed and begin their tenure when he becomes President.

## Constitution and By-Laws

- a) He shall become acquainted with the duties and problems of Secretary through personal visits and other contacts.
- b) He shall work with the Public Relations Chairman and the Newsletter Chairman in informing the Public and the Academy members of the programs and activities of the Alabama Academy of Science, its officers, and members.
- c) He shall perform any other duties delegated by the President.
- d) In the absence of the President, he shall chair all meetings.

Sec. 5. *Second Vice-President:* During his tenure, he shall review the financial and publication operations of the Academy.

- a) The Second Vice-President shall work with the Section Chairmen and Vice-Chairmen in building up membership in their sections and the Academy
- b) He shall become acquainted with the duties and problems of the Treasurer and the Journal Editor through personal visits and other contacts.

Sec. 6. *Section Chairmen:* Each chairman in cooperation with the Vice-Chairman, shall be responsible for presiding over, and planning and arranging the program of this section.

- a) The Chairman shall be responsible for transmission of program material to the Secretary by the deadline recommended by the Secretary and approved by the Executive Committee.
- b) The Chairman, in cooperation with the Vice-Chairman, shall endeavor to build up the membership of the Section.

Sec. 7. *Section Vice-Chairmen:* Each Vice-Chairman shall cooperate with the Chairman in the efficient handling of all sessions at the annual meeting.

- a) The Vice-Chairman shall be secretary of the business meeting of the Section and make his report to the Academy Secretary before the annual business meeting.
- b) In the event that the Office of Section Chairman is vacated, the Vice-Chairman shall serve as temporary Chairman.
- c) He shall be a member of the Membership Committee of the Academy and shall be responsible for building up the membership in his Section with the assistance of the Chairman.

Sec. 8. *Secretary:* The Secretary shall keep the minutes of the Executive Committee and of the Academy as a whole.

- a) Shall be responsible for the arrangements of the annual meeting, including the drawing up of the general program and the arranging of the sectional programs sent him by the Section Chairmen.

## Constitution and By-Laws

- b) He shall maintain the current membership roll of members and Fellows of the Academy and provide the President, Treasurer, and Archivist with a revised roll shortly after the annual meeting upon receipt from the Treasurer, of a list of members dropped for non-payment of dues. He shall submit a roll of members of the Academy to AAAS in alternate years for the purpose of verifying which members are Fellows of AAAS.
- c) He shall notify applicants of action on their applications for membership.
- d) The Secretary shall join the President for the site visit to the host institution to obtain information on arrangements for the annual meeting.
- e) Shall perform such other duties as may be assigned to him by the Executive Committee.

Sec. 9. *Treasurer:* The Treasurer shall be in charge of all funds of the Academy derived from dues and fees, but not special funds held by the Trustees, as provided in the Constitution.

- a) The Treasurer shall send dues statements to the members for the next calendar year by November 15, followed by a second notice on January 15 to those not remitting payment. A list of members in arrears as of the annual meeting shall be sent to the Secretary before May 1.
- b) The Treasurer shall prepare a budget for the next fiscal (calendar) year and present it at the Fall Executive Committee meeting.
- c) He shall make only such disbursements as are approved in the budget.
- d) He shall check the membership roll furnished him by the Secretary for payment of dues and forward the revised roll to the Secretary.
- e) He is required to be bonded.

Sec. 10. *Councilor of the AAAS:*

- a) He shall represent the Academy on the Council of the American Association for the Advancement of Science (AAAS) and the Conference.
- b) He shall attend any other meetings of the AAAS conventions which shall be deemed of interest to the Academy.
- c) He shall make a report at the Spring Executive Committee meeting.
- d) The President is authorized to appoint a substitute or alternate Councilor of the AAAS.
- e) Other delegates up to five in number may be designated by the President to attend the annual meeting of the AAAS.



## Constitution and By-Laws

### Sec. 11. *Editor of the Journal:*

- a) He shall be responsible for publication of the Journal of the Alabama Academy of Science.
- b) He shall be an ex-officio member of the Editorial Board.

### Sec. 12. *Counselors of the Junior Academy:* The Counselors of the Junior Academy shall supervise the activities of the Junior Academy for the Senior Academy.

### Sec. 13. *State Coordinator of Regional Science Fairs:* The State Coordinator of Regional Science Fairs shall supervise the activities of the Regional Science Fairs.

## ARTICLE VI. *PROGRAM RULES*

### Sec. 1. Titles and abstracts of papers to be presented at the annual meeting of the Academy must be sent to the Chairman of the Section in which the paper is to be presented prior to the date set by the Executive Committee. A non-member may read a paper on the invitation of the respective Section Chairman.

### Sec. 2. The Chairman shall compile the section program and forward it in standard format to the Secretary by the time set by the Executive Committee.

### Sec. 3. The program of the annual meeting shall include the following features:

- a) A meeting of the Executive Committee.
- b) The Annual Business Meeting of the Academy.
- c) Sectional meetings.
- d) Annual banquet.
- e) Other activities in keeping with the purposes of the Academy.

## ARTICLE VII. *JOURNAL*

### Sec. 1. The Journal of the Academy shall be published at least once and not more than four times each year at the discretion of the Editorial Board. It shall contain an account of the business transacted at the annual meeting, papers of outstanding merit, abstracts of all other papers, and such other materials as the Editor and the Editorial Board may think proper.

## ARTICLE VIII. *THE ALABAMA JUNIOR ACADEMY OF SCIENCE*

### Sec. 1. The Academy shall sponsor and supervise the Alabama Junior Academy of Science, composed of high school science clubs.



## Constitution and By-Laws

- Sec. 2. Counselors of the Junior Academy are officers of the Academy and are elected as provided in Article VIII of the Constitution.

### ARTICLE IX. *REGIONAL SCIENCE FAIRS*

- Sec. 1. The Academy shall sponsor and supervise the Alabama Regional Science Fairs.
- Sec. 2. The State Coordinator of Regional Science Fairs is an officer of the Academy and is elected as provided in the Constitution.

### ARTICLE X. *AMENDMENTS*

- Sec. 1. The By-Laws may be amended by a plurality vote of the Executive Committee present at any annual meeting or at any special meeting for that purpose.

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- (Possibly amended on other occasions between 1930 and 1957. Minutes not available.)

## Notes

## Notes

# THE JOURNAL OF THE ALABAMA ACADEMY OF SCIENCE

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ADVANCEMENT OF SCIENCE

VOLUME 48

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NUMBER 4

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*Submission of Manuscripts:* Submit all manuscripts and pertinent correspondence to the EDITOR. For style details, follow Instruction to Authors, J. Ala. Acad. Sci. 48:42-43, 1977.

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RANGE EXTENSION OF *Phagocata bursaperforata*  
(TURBELLARIA, TRICLADIDA) INTO AN  
ALABAMA CAVE<sup>1</sup>

Jerry H. Carpenter

Department of Biological Sciences, Northern Kentucky University  
Highland Heights, KY 41076

**Abstract.** The distribution of *Phagocata bursaperforata* (Turbellaria, Tricladida) is extended more than 100 miles from the previously known range of surface pools on granite outcrops in DeKalb and Rockdale counties, Georgia, to include Eudy Cave, Marshall County, Alabama. Surface pool and cave pool habitats are compared. Species dispersal is hypothesized to be by normal surface mechanisms rather than by ground water movement.

INTRODUCTION

*Phagocata bursaperforata* Darlington, 1959, was originally discovered living in small pools on granite outcrops in Georgia. Darlington collected his type specimens from pools on Stone Mountain, DeKalb County, Georgia. He also found specimens on Mount Panola, Rockdale County, Georgia. The only other known locality is over 100 miles away in Eudy Cave, Marshall County, Alabama, where I collected many specimens on 10 May 1969.

GENERAL DESCRIPTION

*Phagocata bursaperforata* is a slender planarian (Fig. 1) about 1 mm wide and usually less than 14 mm long. The anterior margin of the head is slightly convex with long auricles projecting antero-laterally. Eyes and pigment are lacking. It differs from all other *Phagocata* in that it has a bursa-intestinal duct, which connects the bursa with the right posterior intestinal trunk. It can also be distinguished from other North American *Phagocata* by the following combination of characters: elongate auricles, absence of eyes, and prepharyngeal testes.



Fig. 1. *Phagocata bursaperforata* live after feeding on chips of dried blood.

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## DISCUSSION

While collecting the worms from quiet rimstone pools just past the twilight zone in Eudy Cave, I noted the long auricles, which immediately reminded me of the cave alloecoel *Geocentrophora cavernicola* (Carpenter 1970); but the position of the pharynx was definitely that of a tri-clad. Then I realized that these specimens also resembled drawings and descriptions I had seen of *P. bursaperforata*. Serial sections of six specimens confirmed the diagnostic characteristics. In April 1970 I collected *P. bursaperforata* from surface pools on Mount Panola to further confirm the identification; specimens from Eudy Cave are indistinguishable from Mount Panola specimens.

These two habitats are strikingly different in several respects. While caves have a tendency to be constant in light, temperature, and humidity, the granite outcrops are subject to strong fluctuations in all of these. The sunlight is so intense that Darlington noted daily fluctuations in water temperature on the slopes as much as from 0° to 18°C. From April to November the pools become dry and baked most of the time. Perhaps the only major characteristic these two habitats have in common is that they are marginal habitats where primary productivity, food, and competition are scarce. As Darlington (1959) noted, other planarians are scarce on the outcrops and probably cannot survive from season to season.

It appears that *P. bursaperforata* is better adapted to the cave environment than to the granite outcrop pools both morphologically (with the lack of eyes and pigment) and physiologically (with the preference for cooler and more constant conditions). Darlington (1959) noted that his specimens remained alive at room temperature for only about 3 weeks, but at 15°-17°C they survived more than 3½ months. I have maintained specimens from Eudy Cave at 13°C for over a year. During this period they fed readily on my standard culture food, chips of dried blood. Neither Darlington nor I observed any signs of encystment as is frequently characteristic of worms prone to inhabit small bodies of water that either become very warm or dry up during some seasons. Cave planarians do not encyst because the high humidity in caves makes this unnecessary. It should also be noted that the population density of *P. bursaperforata* in the surface pools was much lower than in the cave pools where approximately 100 specimens were collected in about ½ hour.

With these observations in mind, it does not seem strange to find *P. bursaperforata* in a cave, but it is more of a problem to explain its existence on the granite outcrops. There are no caves in the area that might serve as sanctuaries. Although the other turbellarians on the outcrops have special mechanisms to help them survive desiccation in the summer months (the alloecoel *Geocentrophora marcusii* Darlington, 1959, encysts readily, and the rhabdocoel *Mesostoma georgianum* Darlington, 1959, lays resistant eggs), *P. bursaperforata* apparently does not. In order for it to survive it probably burrows deep into the mud and debris at the bottom of pools located at the base of the granite outcrops. *Phagocata bursaperforata* is considerably less numerous in pools on the granite slopes than in pools at the base, which contain water during longer periods of the year (Darlington 1959).



## *Phagocata* in an Alabama Cave

If we accept the hypothesis that *P. bursaperforata* is cave adapted and that caves are its normal habitat, we need to explain not only how it can survive in the granite outcrop area but also how it managed to get there from a cave area. If this were a troglobitic species (i.e., one so adapted to cave life that it is confined to caves), its disjunct range would have to be explained either by recent travel through ground water or by the survival of relict populations that were at one time (perhaps thousands of years ago) members of a more widespread population. But *P. bursaperforata* obviously is not troglobitic since it occurs on the granite outcrops year after year. Therefore, although we cannot rule out the travel by ground water and relict population mechanisms, it is perhaps more likely that these worms are (or were) dispersed by the usual surface mechanisms such as normal movements through rivers and streams or via the feet of aquatic birds.

Although Darlington (1959) stated that he could not find *P. bursaperforata* in the surrounding area, it seems likely that it does exist in areas other than Eudy Cave and the granite outcrops. I predict that some day other populations of *P. bursaperforata* will be found in similar marginal habitats in northern Georgia and Alabama.

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COMPARATIVE FOOD HABITS OF SMALLMOUTH AND LARGEMOUTH  
BASSES IN PICKWICK RESERVOIR<sup>1,2</sup>

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*Abstract.* The stomach contents are described for 432 smallmouth bass and 553 largemouth bass collected from Pickwick Reservoir by angling and electrofishing. Significant differences in the frequency of empty stomachs relative to season, but not relative to fish length, were noted for both species. Substantial differences in the relative volume of various components of the diet were observed with increasing length in smallmouth bass; smaller changes were found in largemouth bass. Observations indicate that differences in the relative mouth size of the two species of bass may lead to differences in food habits of the coexisting bass populations in Pickwick Reservoir. Seasonal fluctuations in composition of the diet were similar for both species.

INTRODUCTION

The sport fish harvest of black bass from Pickwick Reservoir is dominated by smallmouth bass (*Micropterus dolomieu*) and largemouth bass (*Micropterus salmoides*). Hubert (1976) has indicated that the growth of smallmouth bass in the reservoir is exceptionally fast, while growth of largemouth bass is slow relative to other southeastern impoundments. Smallmouth bass are distributed throughout the reservoir, but the majority caught by fishermen are within the upstream 20 km of the 75 km-long impoundment. Largemouth bass are abundant in population surveys and in the sport fish catch over the entire reservoir. The coexistence of populations of smallmouth and largemouth basses in the same body of water allows a comparison of food habits and evaluation of the competition for food between these two closely related species. The purpose of this paper is to describe the food habits of the two bass species and to evaluate the similarities and differences in their diet.

STUDY AREA

Pickwick Reservoir is a 17,400-ha mainstream impoundment on the Tennessee River. The reservoir is bordered by the states of Alabama, Mississippi, and Tennessee. Pickwick Reservoir is a relatively old impoundment; the dam was closed in 1938. Pickwick Dam, located at

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<sup>2</sup>This article is a Government publication and not subject to copyright.

## Food Habits of Bass in Pickwick Reservoir

Tennessee River Mile (TRM) 206.7, is the second in a series of main-stream dams. The upstream boundary of Pickwick Reservoir is Wilson Dam, located at Florence, Alabama, at TRM 259.4. Wilson Dam discharges a mean annual volume of approximately 1,000 m<sup>3</sup>/s into Pickwick Reservoir. From Wilson Dam downstream to approximately TRM 247 (20 km distance), the Tennessee River flows within its original banks and is distinctly riverine in nature. Below TRM 247, the river spreads out to inundate overbank areas and the velocity of flow declines to form a more reservoir-like habitat.

### METHODS AND MATERIALS

Specimens were collected by angling and electrofishing throughout Pickwick Reservoir. Fish stomachs were collected by a creel clerk from anglers on the headwaters of Pickwick Reservoir and in bass fishing tournaments throughout the reservoir. Angler-harvested fish accounted for 78 percent of the total sample. Electrofishing was utilized primarily to supplement the angler-harvested samples during low-harvest fishing periods, especially late fall to midwinter, and to obtain specimens smaller than the size caught by fishermen. All stomach samples were gathered between April 1973 and September 1975.

Specimens were weighed, measured, and sexed in the field. Stomachs, including intestines and attached viscera, were removed and placed in individual jars with 10 percent formalin. In the laboratory, the stomachs were washed to remove excess formalin and cut longitudinally to remove the contents. Food items were separated by taxa and enumerated, and volume was determined in graduated cylinders after each taxon was drained and blotted.

For comparative purposes, food items were categorized as decapods, insects, clupeids, other identified fishes, unidentified fishes, and other food items. The percent by volume and the percent frequency of occurrence in stomachs containing food items of each category were determined for both species over five length intervals from 100 to 599 mm and over the four seasons.

Statistical comparisons of the qualitative and quantitative nature of each species' diet relative to total body length and season were performed. Statistical methods included Chi-square analysis, nonparametric linear regression, and normal theory linear regression. A probability of 0.05 was chosen for critical values of all applied tests.

### RESULTS

Stomachs from 432 smallmouth bass and 558 largemouth bass between 100 and 599 mm total length were examined. One hundred eighty-four smallmouth bass and 244 largemouth bass contained food items.

#### Quantitative Comparisons

A 2 × 2 contingency Chi-square analysis (Steel and Torrie 1960) did not show a significant difference ( $0.05 < p < 0.10$ ) in the proportion of empty stomachs of largemouth bass taken by the two collection techniques,

but a significant difference in the smallmouth bass collection methods ( $p < 0.01$ ) was indicated. Only 27 of 95 smallmouth bass stomachs obtained by electrofishing contained food items. Sixty-three of the smallmouth bass were collected by electrofishing between November 1 and February 29; 32 were obtained during the remainder of the year. Eighty-seven percent of the November through February samples were empty compared to 48 percent during the eight other months. These observations indicate that the significant difference in the frequency of empty stomachs between angler-harvested and electrofishing smallmouth bass samples was not a function of collection technique but a result of the high proportion of electrofishing samples collected during cold weather when feeding activity was reduced. Angler harvested and electrofishing samples were, therefore, pooled for the purpose of comparing the frequency of empty stomachs between length groups and seasons.

Possible differences in the frequency of empty stomachs among 100 mm length groups between 100 and 599 mm were tested using nonparametric linear regression in a  $5 \times 2$  table (Steel and Torrie 1960). No statistically significant difference in the frequency of empty stomachs was shown between the five length groups for either smallmouth bass ( $0.60 < p < 0.70$ ) or largemouth bass ( $0.10 < p < 0.20$ ).

To determine if a statistically significant difference in the frequency of empty stomachs occurred among the four seasons, a Chi-square test of independence was utilized. A statistically significant difference was observed between seasons in both smallmouth bass ( $p < 0.01$ ) and largemouth bass ( $p < 0.01$ ). The lowest frequency of empty stomachs was observed in winter samples (37 percent for both species) and the highest in the fall collections (82 and 81 percent for smallmouth bass and largemouth bass, respectively). Spring and summer samples were 54 and 60 percent empty among the smallmouths and 51 and 55 percent empty among the largemouths.

### Qualitative Comparisons

#### Length Related Trends

The percent by volume and the percent frequency of occurrence of six food item categories over five length intervals for smallmouth and largemouth basses are presented in Table 1. Relations between the percent by volume of three food item categories and length were defined by linear regression. For smallmouth bass, the relations between percent by volume of (1) decapods ( $D_S$ ), (2) insects ( $I_S$ ), and (3) all fish ( $F_S$ ) with increasing total length ( $L_S$ ) in mm are as follows:

$$(1) D_S = 58.5 - 0.11 L_S \quad (r^2 = 0.90)$$

$$(2) I_S = 12.2 - 0.02 L_S \quad (r^2 = 0.74)$$

$$(3) F_S = 26.1 + 0.14 L_S \quad (r^2 = 0.90)$$

Length alone accounted for a high proportion of the variance in the quantitative composition of smallmouth bass food.

# Food Habits of Bass in Pickwick Reservoir

Table 1. Percent by volume (1) and percent frequency of occurrence (2) of major food items in five size classes of smallmouth bass and largemouth bass, Pickwick Reservoir.

Smallmouth Bass	Length Class (mm)									
	100-199		200-299		300-399		400-499		500-599	
	1	2	1	2	1	2	1	2	1	2
Decapods	47.5	35.7	24.7	36.8	14.5	24.7	3.2	11.1	0.5	6.7
Insects	8.5	35.7	8.7	21.1	0.6	4.9	0.1	5.6	0.6	20.0
Clupeids	7.1	3.6	37.3	23.7	63.5	43.2	70.2	44.4	37.4	53.3
Other identified fish	16.3	14.3	16.5	13.2	10.2	16.0	15.5	11.1	53.3	30.0
Unidentified fish	17.0	35.7	12.7	26.3	11.0	30.9	9.7	41.7	8.2	20.0
Other food items	3.5	3.6	0.1	5.3	0.1	3.7	1.3	2.8	0.0	0.0
Total sample size	24		97		207		75		29	
Number empty	10		59		126		39		14	

Largemouth Bass	Length Class (mm)									
	100-199		200-299		300-399		400-499		500-599	
	1	2	1	2	1	2	1	2	1	2
Decapods	0.9	11.1	13.4	15.0	3.7	10.5	0.5	3.6	*	3.8
Insects	1.9	44.4	0.3	10.0	0.2	10.5	*	8.9	0.0	0.0
Clupeids	78.3	44.4	52.1	30.0	59.8	48.8	80.2	60.7	87.9	53.8
Other identified fish	18.9	22.2	22.0	30.0	31.9	18.0	12.4	12.5	10.3	14.5
Unidentified fish	0.0	0.0	12.0	45.0	2.7	18.0	5.5	16.3	1.7	30.8
Other food items	0.0	0.0	0.0	0.0	1.6	0.8	1.3	1.8	0.1	3.8
Total sample size	14		39		330		117		56	
Number empty	5		19		197		61		30	

\*Calculated value less than 0.05.

For largemouth bass, the percent by volume of (1) decapods ( $D_1$ ), (2) insects ( $I_1$ ), and (3) all fish ( $F_1$ ) changed very little with increasing length ( $L_1$ ). The calculated regressions for the largemouth bass were:

$$(1) D_1 = 8.84 - 0.01 L_1 \quad (r^2 = 0.17)$$

$$(2) I_1 = 1.91 - 0.004 L_1 \quad (r^2 = 0.64)$$

$$(3) F_1 = 89.2 + 0.01 L_1 \quad (r^2 = 0.25)$$

The percent frequency occurrence of the three major food classes (i.e., decapods, insects, and fishes) was related to length of smallmouth bass and largemouth bass. Nonparametric linear regression in a  $5 \times 2$  table was utilized to determine if the frequency of occurrence of decapods, insects, and all fishes changed with increasing bass length. For smallmouth bass between 100 and 599 mm, the calculated Chi-square values and associated slopes indicated a statistically significant decrease in the occurrence of decapods ( $p < 0.01$ ) and insects ( $0.02 < p < 0.05$ ) and a significant increase in fish ( $p < 0.01$ ) with increasing length. For largemouth bass, a statistically significant increase in frequency occurrence of fish ( $p < 0.01$ ) was observed, while the frequency of insects ( $p < 0.01$ ) decreased with increasing total length. No statistically significant change in decapod frequency ( $0.05 < p < 0.10$ ) was noted.

### Seasonal Trends

The seasonal composition of the diet by percent volume and percent frequency of occurrence for both bass species is presented in Table 2. Fishes and decapods dominated the winter diet of smallmouth bass, while insects were completely lacking. During winter, the highest volume and occurrence of *Dorosoma* of any season were observed. Seventy-seven percent of the *Dorosoma* consumed during the winter were threadfin shad (*D. petenense*). The spring food of smallmouth bass was also dominated by clupeids; both the volume and frequency occurrence of decapods increased over the winter. In spring, insects occurred in 17.8 percent of the stomachs containing food items but comprised only 5.0 percent of the total spring food volume. Summer samples showed continued utilization of decapods and insects as a small portion of the diet, but fish dominated by volume and frequency occurrence. By volume, the summer food was primarily fishes other than clupeids, especially sunfish (*Lepomis* spp.) and freshwater drum (*Aplodinotus grunniens*). During fall, a decline in both the volume and occurrence of decapods was observed, while utilization of fishes other than clupeids increased. Clupeids occurred in 21.4 percent of the stomachs and comprised 25.2 percent of the volume of fall food items. Fishes other than clupeids were observed in 14.3 percent of the stomachs and comprised 66.3 percent of the total volume.

Seasonal patterns were also evident in largemouth bass. Clupeids dominated the diet of largemouth bass throughout the year; however, significant changes in the volume and occurrence of clupeids were noted over the seasons. Clupeids comprised 85.5 percent of the winter food by volume, but fishes other than clupeids and decapods also occurred during the winter. Spring food was essentially the same as winter food, except

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Table 2. Percent by volume (1) and percent frequency of occurrence (2) of major food items by the four calendar seasons for smallmouth bass and largemouth bass, Pickwick Reservoir.

Smallmouth Bass	Winter		Spring		Summer		Fall	
Food items	1	2	1	2	1	2	1	2
Decapods	10.2	21.3	12.2	27.8	6.5	24.2	0.8	14.3
Insects	0.0	0.0	5.0	17.8	4.1	15.2	*	7.1
Clupeids	67.1	68.1	59.3	27.8	22.2	21.2	25.2	21.4
Other identified fish	13.0	10.6	11.4	17.8	36.0	12.1	66.3	14.3
Unidentified fish	9.7	38.3	9.2	22.0	31.0	45.5	7.6	34.5
Other food items	0.0	0.0	2.6	7.8	0.0	0.0	0.0	0.0
Total sample size	75		196		82		79	
Number empty	28		106		49		65	

Largemouth Bass	Winter		Spring		Summer		Fall	
	1	2	1	2	1	2	1	2
Decapods	3.2	13.5	0.5	3.4	1.1	5.9	8.5	33.3
Insects	0.0	0.0	*	5.7	0.3	15.7	0.1	16.7
Clupeids	85.5	64.9	90.1	58.6	42.9	39.2	87.5	33.3
Other identified fish	8.1	13.5	5.3	10.3	46.2	24.5	0.3	5.6
Unidentified fish	3.3	24.3	2.9	20.7	7.6	24.5	3.7	22.2
Other food items	0.0	0.0	1.2	2.3	1.9	1.0	0.0	0.0
Total sample size	59		176		226		97	
Number empty	22		89		124		79	

\*Calculated value less than 0.05.



decapods declined and insects appeared (less than 0.05 percent of volume) in the diet. A significant change in diet occurred among the largemouth bass in summer. The occurrence of invertebrates and fishes other than clupeids increased substantially; fishes other than clupeids, primarily centrarchids and freshwater drum comprised 46.2 percent of the volume of summer food. In the fall increased utilization of decapods and insects and a decline in fishes other than clupeids was noted. Clupeids made up 87.5 percent by volume of the fall diet.

### Diet Composition

Qualitatively, the smallmouth bass diet was varied. Decapods consisted primarily of crayfish of the genus *Orconectes*; of 36 crayfish identified, 32 were *Orconectes* and four were *Cambarus*. The insects consumed by smallmouth bass were primarily Plecoptera (56 percent by number); but Odonata and Ephemeroptera (28 and 9 percent, respectively) were also abundant. Coleoptera, Diptera, and Trichoptera made up the remaining 7 percent. With the exception of a few beetles, all insect food items were immature aquatic forms.

The clupeids consumed by Pickwick Reservoir smallmouth bass were *Dorosoma petenense* (threadfin shad), *Dorosoma cepedianum* (gizzard shad), and *Alosa chrysochloris* (skipjack herring). Eighty-two clupeids were identified: 50 threadfin shad, 28 gizzard shad, and 4 skipjack herring. Threadfin shad appeared to be utilized more than gizzard shad in small size smallmouth bass; all shad in smallmouth bass less than 300 mm were threadfin shad. Threadfin shad comprised 65 percent by number of *Dorosoma* in 300-399 mm smallmouths, while a 1:1 ratio of the two shad species was observed in smallmouth bass exceeding 400 mm.

Other fishes utilized were Cyprinidae, Sciaenidae, Centrarchidae, Ictaluridae, and Percidae. Minnows and freshwater drum composed 37 percent each of identified fish other than clupeids. Minnows of the genera *Notropis*, *Hybopsis*, and *Pimephales* were identified from smallmouth bass stomachs. Centrarchids were composed of *Lepomis macrochirus* (bluegill), *Lepomis megalotis* (longear sunfish), *Lepomis microlophus* (reardear sunfish), and a single smallmouth bass fingerling.

The qualitative food habits of largemouth bass did not differ greatly from the smallmouth bass. All identified decapods were *Orconectes*. Insects utilized were Ephemeroptera (34 percent by number), Odonata (24 percent), Coleoptera (21 percent), Diptera (19 percent), and Plecoptera (2 percent). Identified clupeids consisted of 72 threadfin shad, 40 gizzard shad, and two skipjack herring. As in smallmouth bass, a greater utilization of threadfin shad than gizzard shad was noted in small size largemouth bass. Seventy percent of the *Dorosoma* in largemouth bass less than 300 mm were threadfin shad. In largemouths of the 300-399 mm class, 72 percent were threadfin shad; they also accounted for 57 percent of the *Dorosoma* in specimens over 400 mm. Centrarchidae, Sciaenidae, Cyprinidae, Cyprinodontidae, Ictaluridae, and Percidae were identified from largemouth bass stomachs. Forty-eight percent of the identified fishes other than clupeids were centrarchids. Bluegills, longear sunfish, and redear sunfish were the most abundant centrarchids. Two smallmouth bass fingerlings and one largemouth bass fingerling were

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identified. Freshwater drum comprised 27 percent and cyprinids 17 percent by number of the identified fish other than clupeids.

### DISCUSSION

Of the 432 smallmouth bass stomachs examined from Pickwick Reservoir, 57 percent were empty. The frequency of occurrence of empty smallmouth bass stomachs is not well documented. Doan (1940) indicated a range of from 13 percent empty in 6-9 inch smallmouth bass to 50 percent empty in fish 15 inches or greater. Tate (1949) observed a difference in the frequency of empty stomachs (13.5 to 34.4 percent) among four streams. Webster (1954) found 64 percent of the smallmouth bass stomachs empty in fish collected from Cayuga Lake, New York, and further noted differences in the frequency of empty stomachs related to the site of collection.

Fifty-six percent of the Pickwick Reservoir largemouth bass stomachs were empty. Snow (1971) observed that 68 percent of the largemouth bass caught by anglers from Wisconsin's Murphy Flowage had empty stomachs. Zweiacker and Summerfelt (1974) found 55 percent of the largemouth stomachs, analyzed by gastroscope, were empty in an Oklahoma reservoir. When they related their observation to four other largemouth bass studies using the same methods (Dubets 1954, Schneidermeyer and Lewis 1956, Moehn 1956, and Lambou 1961), they found that the frequency ranged from 49.3 to 61.0 percent.

The findings of Doan (1940) suggest that the frequency of empty stomachs in smallmouth bass may be positively correlated to the length of the fish. Lewis et al. (1974) found the percent of empty largemouth bass stomachs was independent of the size. The frequency of empty stomachs fluctuated over the five length groups of both smallmouth and largemouth bass from Pickwick Reservoir. A statistically significant trend was not shown in either of the bass species.

Within Pickwick Reservoir the highest frequency of empty (smallmouth and largemouth bass) stomachs occurred in the fall (82 and 81 percent empty, respectively). The high frequency of empty stomachs may have reflected decreased feeding activity or a relative scarcity of vulnerable forage during the fall period. The lowest frequency of empty stomachs (37 percent for both species) was observed during winter. The majority of bass in the winter sample were collected between February 1 and March 21. During this interval, extensive mortality of threadfin shad occurs on the Tennessee River. The high vulnerability of dying threadfin shad and the reduced digestive rate of the basses caused by low water temperatures may have accounted for the low frequency of empty stomachs during the winter. The frequency of empty stomachs during spring and summer was similar to the average for both species; however, the spring frequency was less than that observed in the summer for both species.

Of all the smallmouth bass stomachs containing food, 67 percent had a single food item in the stomach. Seventy percent of the largemouth bass stomachs with food contained only one forage organism. Lewis et al. (1974) observed that 90 percent of the largemouth bass from Crab

Orchard Reservoir contained only one food item. Seasonal variation in the number of food items in the stomach was noted in both bass species. The smallest percentage of fish consuming a single food item occurred during the winter for both smallmouth (42 percent) and largemouth (43 percent) basses. Over the other three seasons, the percentage was much higher in both smallmouth (66-86 percent) and largemouth (76-78 percent) basses. The low frequency of stomachs containing a single food item during the winter is attributed to predation upon moribund threadfin shad during late winter when the majority of basses collected had multiple shad (2-20) in the stomach.

In past food-habit analyses, smallmouth bass have often been characterized as being less piscivorous and more benthophagic than largemouth bass. The change in diet of smallmouth bass fingerlings with increasing size is well documented (Wichliff 1920, Tester 1932, Doan 1940, Lachner 1950, Webster, 1954, Applegate et al. 1966, Mullan and Applegate 1967, and Warden and Hubert, in press). The present Pickwick Reservoir study shows a significant change in the composition of the diet of juvenile and adult smallmouth bass with increased length. Most previous smallmouth bass studies have generalized smallmouth bass food habits for bigger than fingerlings (Tester 1932, Surber 1941, Webster 1954, and Mullan and Applegate 1967). Doan (1940) observed a gradual switch from decapods and insects to fish with increasing length from 3 to 15 inches (7.5 to 35 cm). The observations of Doan are corroborated by this study. At 100-199 mm, the volume of the smallmouth bass diet is made up of approximately 50 percent fish, 40 percent decapods, and 10 percent insects. When the smallmouths attain 300-399 mm, the diet is composed of approximately 75 percent fish, 20 percent decapods, and 5 percent insects. In smallmouth bass over 500 mm, more than 95 percent of the diet was fish.

Many investigators have found a change in largemouth bass food habits with increasing fingerling size (Murphy 1949, Mullan and Applegate 1967, Chew 1974, Applegate et al. 1967, Goodson 1965, Kramer and Smith 1960, Hodson and Strawn 1969, McCammon et al. 1964, and Pasch 1974). Pickwick Reservoir samples indicate that 60-99 mm largemouth bass fingerlings are highly piscivorous with fish occurring in 65 percent of the stomachs (Warden and Hubert, in press, Tenn. Acad. Sci.). A statistically significant change in the frequency occurrence of fish and insects between 100 and 599 mm was still noted.

In many ways, the food habits of Pickwick Reservoir smallmouth and largemouth basses were similar. The frequency of empty stomachs in both species was almost identical, and the qualitative nature of the diet in both species was quite similar. Although the species were different in respect to the volume and frequency occurrence of different food items eaten at a given length, the composition of the smallmouth bass diet at a given interval was remarkably similar to the next shorter largemouth bass interval. An exception occurs with the 100-199 mm largemouth bass, but a small sample of only fourteen specimens may have biased the results. An example of the similarity is taken from the 300-399 mm smallmouth bass compared to the 200-299 mm largemouth bass. Smallmouth bass of 300-399 mm consumed 14.5 percent decapods, 0.6 percent insects, and 63.5 percent clupeids by volume; largemouth bass of

## Food Habits of Bass in Pickwick Reservoir

200-299 mm consumed 13.4 percent decapods, 0.3 percent insects, and 52.1 percent clupeids. A high positive correlation is observed between the percent by volume of decapods, insects, clupeids, and all fishes in the diet of 300-399 and 400-499 mm smallmouth bass and the next shorter length interval of largemouth bass.

Mouth size can determine the size of various forage organisms which can readily be swallowed by bass (Lawrence 1957). The observations of this study suggest that differences in the relative mouth size of the two bass species may lead to differences in food habits of Pickwick Reservoir fishes. At least two possibilities are implied: (1) species differences in distribution or behavior may not be highly significant in governing the diet of reservoir basses or (2) the various forage organisms are available in the specialized habitats utilized by each bass species within the reservoir. Further evaluation of the relation between mouth size, diet, and habitat selection of each species is needed to reveal the competitive aspects of coexisting bass populations in reservoirs.

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SPRING STOMACH CONTENTS OF *Lepomis* FROM  
THE WILSON DAM TAILWATER<sup>1,2</sup>

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*Abstract.* The stomach contents are described for 181 bluegill and 211 longear sunfish collected in the spring from the Wilson Dam Tailwater by electrofishing. Qualitative aspects of the fish's stomach contents were described for 25 mm length intervals. Observations indicated that fish eggs and insects were the major components of the spring diet.

INTRODUCTION

This study was performed to describe the spring food habits of bluegill, *Lepomis macrochirus* (Rafinesque), and longear sunfish, *Lepomis megalotis* (Rafinesque) in the tailwater of a Tennessee River mainstream impoundment. Special interest was focused on the extent of predation by sunfish on fish eggs and larvae.

METHODS

Collections were made from the Wilson Dam tailwater near Florence, Alabama. Wilson Dam, located at Tennessee River Mile (TRM) 259.4, discharges a mean annual volume of 1,000 m<sup>3</sup>/s into the tailwater. From Wilson Dam downstream to approximately TRM 247, the Tennessee River flows within its original banks and is riverine in nature. Below TRM 247, the river inundates the flood plain and forms a more reservoir-like habitat due to the influence of Pickwick Dam at TRM 206.7.

Bluegill and longear sunfish from 75 to 199 mm total length were collected by electrofishing between March 10 and May 21, 1975. Fish were placed on ice when collected and later transferred to 10 percent formalin for storage. Twenty-five mm length groups were assigned and stomach contents from all fish within a length group were pooled for analysis (Borgeson 1966). Number and volume of each food type were measured and recorded.

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<sup>1</sup>Manuscript received 4 May 1977; accepted 16 August 1977.

<sup>2</sup>This article is a Government publication and not subject to copyright.



## RESULTS

Analyses of 181 bluegill and 211 longear sunfish stomachs were performed (Tables 1 and 2). Fish eggs made up 67.2 percent of the total number of food items and 59.2 percent of the total volume in bluegill, and 56.1 percent by number and 3.7 percent by volume in longear sunfish. Insects were abundant in the stomachs of both species. Insects accounted for 27.1 percent by number and 32.1 percent by volume of food items in bluegill, and 23.0 percent by number and 22.0 percent by volume in longear sunfish. The insect portion of the diet consisted almost exclusively of Diptera, Ephemeroptera, Coleoptera, and Trichoptera. Chironomid larvae and mayfly nymphs made up more than 90 percent of the number and volume of insects. Decapods were important with respect to volume but represented only 14 of 1,756 food items identified. Larval fish, isopods, mulloscs, arachnids, and annelids were also observed in the stomachs.

## DISCUSSION

Predation on fish eggs by *Lepomis* has been observed in reservoirs. During the filling of Beaver Reservoir on the White River, Arkansas-Missouri, fish eggs comprised up to 3 percent by volume of the stomach contents in *Lepomis* for the April to June period (Mullan and Applegate 1968). In Bull Shoals Reservoir, an older reservoir on the White River, fish eggs formed 23 percent by volume of the total annual stomach contents in 2.0 to 3.9-in (59-99 mm) longear sunfish and 3 percent in bluegill. Fish eggs composed only 3 percent of the stomach contents in 4.0 to 7.9-in (102-201 mm) longear sunfish, but made up 19 percent of the volume in bluegill of the same size (Applegate, et al. 1966). In a California storage reservoir, fish eggs comprised 54.1 percent of the total annual number of organisms (21.7 percent by volume) in 4.0 to 5.9-in (102-150 mm) bluegill and 68.1 percent (17.7 by volume) in 6.0 to 9.9-in (152-252 mm) specimens (Goodson 1965). Fish eggs could not be identified with certainty; however, based on egg size and morphology the majority of the eggs in *Lepomis* from the Wilson Dam tailwater were believed to represent freshwater drum, *Aplocheilichthys grunniens* (Rafinesque).

Very few larval fish were found in *Lepomis* from the Wilson Dam tailwater. This agrees with observations made in previous reservoir studies (Applegate, et al. 1970, Mullan and Applegate 1968, Goodson 1965). It may be due to rapid digestion of fragile larva or reduced vulnerability of larval forms to predation of sunfish.

Within the Wilson Dam tailwater, bluegill and longear sunfish are functioning as predators upon early life history stages of other fishes. The impact of *Lepomis* predation upon other fish populations is not well understood, but it may have significant influence in population dynamics in reservoirs and their tailwaters.

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Table 1. Percent of total number and volume of food organisms in bluegill from the Wilson Dam Tailwater, March 10-May 21, 1975.

Length group (mm):	Percent of total number						Percent of total volume					
	75-99	100-124	125-149	150-174	175-199	All sizes	75-99	100-124	125-149	150-174	175-199	All sizes
<u>Food Organism</u>												
Fish eggs		67.1	33.8	21.7	99.4	67.2		23.9	7.1	2.4	89.4	59.2
Larval fish		0.5				0.1		1.6				0.2
Insects	98.5	31.5	52.1	28.3	0.6	27.1	81.5	73.7	77.1	57.7	10.1	32.1
Decapods				4.3		0.2				37.4		6.2
Isopods	1.5	0.9	1.0			0.5	18.5	0.9	4.3			0.7
Molluscs			9.7	43.4		4.1			8.0	2.3		1.2
Arachnids			1.0			0.2			2.0			0.2
Annelids			2.4	2.3		0.6			1.6	0.6		0.2
Number examined	11	59	58	40	13	181						

Table 2. Percent of total number and volume of food organisms in longear sunfish from the Wilson Dam Tailwater, March 10-May 21, 1975.

Length group (mm):	Percent of total number					Percent of total volume				
	75-99	100-124	125-149	150-174	All sizes	75-99	100-124	125-149	150-174	All sizes
<u>Food Organism</u>										
Fish eggs	36.5	60.5	61.5		56.1					
Larval fish		0.5	1.7		0.9	52.6	3.5	4.9		3.7
Insects	63.5	7.6	24.1	25.0	23.0	47.4	33.9	21.7	9.5	2.2
Decapods		0.5	2.7	25.0	1.5		31.1	47.9	87.2	52.7
Isopods		27.6	2.4	37.5	13.8		7.1	4.9	3.1	5.0
Molluscs		0.2	0.7		0.4		0.1	0.8		0.4
Arachnids			0.3		0.1			0.2		0.1
Annelids		2.8	6.3	12.5	3.6		17.1	8.3	0.2	8.6
Number examined	10	105	85	11	211					

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## OPTIMAL DESIGN OF STRUCTURAL TRUSSES USING DYNAMIC PROGRAMMING

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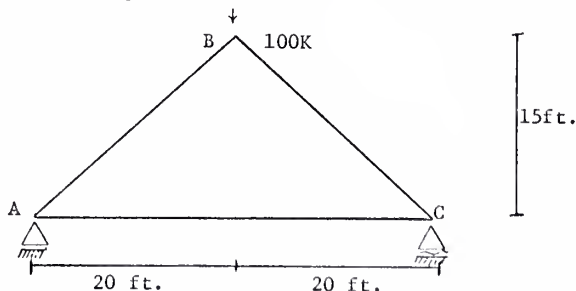
### INTRODUCTION

This paper discusses the problem of optimally designing structural trusses using dynamic programming optimization methods. A general mathematical model of the design problem is formulated. The problem requires that the truss weight, therefore cost, be minimized while meeting the design restrictions of truss stiffness imposed by the designer. This model is then reformulated into a dynamic programming format. A computer program has been written to implement the dynamic programming optimization.

Trusses are often used in construction work, and their contribution to the total weight of the structure can be significant. The weight contribution of a truss depends on the number of truss members, their lengths, and cross-sectional areas. In actual truss design, geometry of the truss (i.e. the depth and panel locations) are pre-established by purlin locations, depth limitations, etc. For any given truss the minimum cross-sectional areas and the maximum truss deflection can be established. Within these specified constraints a truss can then be designed by determining the cross-sectional areas so that the total weight of the truss is minimized. The truss design problem is thus one of determining the optimum cross-sectional areas so that total truss weight is minimized, and all constraints on minimum cross-sectional areas and the truss deflection are satisfied.

### THE TRUSS DESIGN PROBLEM

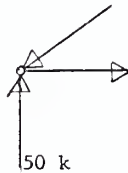
The following diagram shows a simple structural truss with loading and other characteristics given:



The truss is to be built with A36 steel ( $E = 29,000$  ksi) which implies an allowable tension strength of  $\sigma_t = 22$  ksi, and allowable compression strength of  $\sigma_c = 13$  ksi (for the slenderness ratio in this particular truss). The stiffness criterion for the truss permits an allowable deflection at B of .3 inches.

Statis analysis of the truss is summarized as follows:

$$R_A = 50 \text{ k } \uparrow \text{ (by symmetry)}$$



$$\Sigma F_V = 0 \quad AB_B = 50 \text{ k } \downarrow$$

$$AB = \frac{5}{3} (50) = 83.3 \text{ k}$$

$$\Sigma F_H = 0 \quad AC = \frac{4}{3} (50) = 66.7 \text{ k}$$

Truss member selections, based on strength, involve selection of minimum member areas to satisfy strength requirements. Hence, for AB & BC we have

$$83.3/13 = 6.42 \text{ si}$$

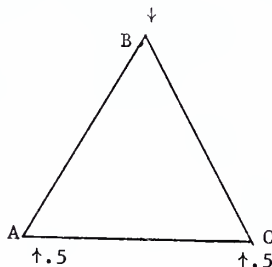
and for AC we have

$$66.7/22 = 3.02 \text{ si}$$

Solution for deflection at B by virtual work where

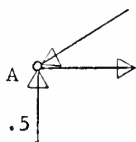
$$\delta = \frac{12}{E} \Sigma \frac{PP'L}{A}$$

involves solution for the  $P'$  above by placing a unit load at B. Diagramatically we have



where  $R_A' = .5$  by symmetry.

# Optimal Design of Structural Trusses



$$\Sigma F_V = 0 \quad AB_V = .5$$

$$AB = \frac{5}{4} (.5) = .83$$

$$\Sigma F_H = 0 \quad AC = \frac{4}{3} (.5) = .67$$

As  $\delta$  is in inches, L in feet, and E is a constant

$$\delta = \frac{12}{29,000} \Sigma \frac{PP'L}{A}$$

we have the following tabular results

Truss Member	L(ft.)	A(si)	P(k)	P'(k/k)	PP'L/A
AB	25	6.42	-83.3	-.83	27.15
BC	25	6.42	-83.3	-.83	271.5
AC	40	3.03	66.7	.67	<u>587.5</u>

$$\Sigma \frac{PP'L}{A} = 1,130$$

which yields

$$\delta = \frac{12}{29,000} [1,130] = .468 \text{ in.} > .3 \text{ in.}$$

and therefore

$$\max \left[ \Sigma \frac{PP'L}{A} \right] = \frac{.3}{.468} [1,130] = 725$$

Next, solving for the relationship between areas and deflection where

$A_1$  = area of member AB and member BC

$A_2$  = area of member AC

we have



Truss Member	L(ft.)	A(si)	P(k)	P'(k/k)	PP'L/A
AB	25	$A_1$	-83.3	-.83	$1,743/A_1$
BC	25	$A_1$	-83.3	-.83	$1,743/A_1$
AC	40	$A_2$	66.7	.67	$1,780/A_2$

Hence, we arrive at the design constraints

$$\left. \begin{array}{l} A_1 \geq 6.42 \text{ si} \\ A_2 \geq 3.02 \text{ si} \end{array} \right\} \text{ strength requirements}$$

$$\left. \frac{3,486}{A_1} + \frac{1,780}{A_2} \leq 725 \right\} \text{ stiffness requirement}$$

and the objective function (which is to be minimized) given by

$$W = 50 A_1 \gamma + 40 A_2 \gamma$$

where  $\gamma$  is a constant to convert square inches of steel to dollars.

Letting (arbitrarily)  $\gamma = 1$ , the objective function is written as

$$W = 50 A_1 + 40 A_2.$$

The design problem thus is concisely stated in mathematical form as

$$\text{Minimize } W = 50 A_1 + 40 A_2$$

$$\text{Subject to: } A_1 \geq 6.42$$

$$A_2 \geq 3.02$$

$$\frac{3,486}{A_1} + \frac{1,780}{A_2} \leq 725$$

and is obviously non-linear due to the last constraint.

The purpose of the above discussion was to illustrate the methods to be employed in developing the mathematical model for a structural truss design problem. The methods can be used for more complicated truss designs than that considered here, and will result in a mathematical model equivalent to that developed above. Once the model has been developed, it can be solved. The method of solution is the topic of the remainder of this paper.

#### MATHEMATICAL MODEL OF THE TRUSS DESIGN PROBLEM

Let  $n$  be the number of different cross-sectional areas of the members in a truss, and  $A_i$  ( $i = 1, 2, \dots, n$ ) be the cross-sectional area of member  $i$ . The conversion of cross-sectional area to weight for member  $i$  is accomplished by multiplying  $A_i$  by a conversion factor  $C_i$ . The objective function,  $W$ , (total truss weight) can thus be written as

## Optimal Design of Structural Trusses

$$\text{Minimize } W = C_1 A_1 + C_2 A_2 + \dots + C_n A_n \quad (1)$$

For each truss member a lower limit on cross-sectional area must be specified. If this limit is  $B_i$ , then a set of  $n$  constraints can be written as

$$\begin{aligned} A_1 &\geq B_1 \\ A_2 &\geq B_2 \\ &\vdots \\ A_n &\geq B_n \end{aligned} \quad (2)$$

Finally, a constraint expressing the maximum allowable truss deflection is written as follows, where  $D_i$  is a specified deflection constant for member  $i$  and  $E^*$  is the maximum allowable total truss deflection.

$$\frac{D_1}{A_1} + \frac{D_2}{A_2} + \dots + \frac{D_n}{A_n} \leq E \quad (3)$$

Stated succinctly, the general truss design problem mathematical model is

$$\begin{aligned} &\text{Minimize } W = C_1 A_1 + C_2 A_2 + \dots + C_n A_n \\ &\text{Subject to: } (1) \ A_1 \geq B_1 \\ &\quad \quad \quad (2) \ A_2 \geq B_2 \\ &\quad \quad \quad \vdots \\ &\quad \quad \quad (n) \ A_n \geq B_n \\ &\quad \quad \quad (n+1) \ \frac{D_1}{A_1} + \frac{D_2}{A_2} + \dots + \frac{D_n}{A_n} \leq E \end{aligned} \quad (4)$$

Obviously, this is a non-linear model (due to the deflection constraint). The model lends itself to solution using the methods of dynamic programming (see references) which will be discussed next.

### DYNAMIC PROGRAMMING FORMULATION

For the general  $n$  member truss design problem (see equation set (4)),  $n$  dynamic programming stages can be defined, each stage associated with a single decision variable  $A_i$  (i.e. truss cross-sectional area). The first  $n$  constraints in the general model simply impose lower limits on the values of the  $A_i$  at the various dynamic programming stages. The last constraint (involving maximum allowable truss deflection) is associated with the state variable (defined as  $S_i$ ,  $i = 1, 2, \dots, n$ ) that is required

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\*  $E$  as used here is not to be confused with its earlier use in the paper.

to implement the dynamic programming approach to solution of the problem.  $S_i$  is, in essence, the amount of  $E$  that can be assumed by the truss members associated collectively with stages  $i, i-1, \dots, 1$ . The dynamic programming recursive optimization proceeds from stage 1 corresponding to decision  $A_1$ , to stage 2 corresponding to decision  $A_2, \dots$ , to stage  $n$  corresponding to decision  $A_n$ . The general recursive relationship for stage  $i$  ( $i = 1, 2, \dots, n$ ) is shown below.

$$f_i(S_i, A_i) = \{C_i A_i + f_{i-1}^*(S_{i-1})\} = \text{weight contribution to } W \text{ at stage } i \text{ from making decision } A_i.$$

$$f_i(S_i, A_i) = \{C_i A_i + f_{i-1}^*(S_i - D_i/A_i)\}$$

$$f_i^*(S_i) = \min_{A_i} \{C_i A_i + f_{i-1}^*(S_i - D_i/A_i)\} = \text{optimal weight contribution to } W \text{ at stage } i$$

$$\text{where } A_i \geq B_i$$

$$E - \frac{D_{i+1}}{A_{i+1}} - \frac{D_{i+2}}{A_{i+2}} - \dots - \frac{D_n}{A_n} \leq S_i \leq E$$

At stage  $n$ , the state variable,  $S_n$ , must satisfy  $S_n \leq E$ .

In order to apply the dynamic programming approach to problem solution, a computer program was written to implement the recursive equations of stage  $i$  for stages  $i = 1, 2, \dots, n$  in that order. The program was written in FORTRAN IV language for the IBM 360/50, but can be readily adopted for use on other systems. Presently trusses having a maximum of 8 areas can be solved for, although this limit can be easily extended. A 4-area truss design example problem required 144 k bytes of main storage space, and had a total run time of 80 seconds. The program logic involves executing the recursive equations for stages  $i = 1, 2, \dots, n$ . At each stage for each  $S_i$  value considered the optimal values of  $A_i$  and  $f_i^*(S_i)$  are determined. When the stage  $n$  analysis is completed the program then determines the unique set of optimal  $A_i$  values, and the optimal value of  $W$ . The program is available from the authors upon request.

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## THE INTEGRATION OF EXPERIENCE AND THEORY IN PHYSICS TEACHING

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A problem with many introductory physics courses is the correlation of material covered in lab with the development of theory in lecture. In some areas there are many good laboratory exercises and the lecture gets ahead. For example there are Ohm's Law, V-I Curves of a Black Box, Series & Parallel circuits, Kirchoff's Law, which would require four weeks. It is hard to justify 16 lectures on electric circuits in an introductory physics course. Then in the area of magnetism there are only a few teaching experiments and the labs get ahead of the lectures.

To avoid being impaled on the horns of this dilemma, the Department of Physics at the University of North Alabama has integrated experience and theory. For scheduling purposes we schedule an official lab time and a separate lecture time, but we meet in a room which can serve as lab or lecture room. The room is equipped with four desk-height tables parallel to the chalkboard in the front of the room. It also contains peripheral units of stand-up height. Experiments can be performed at any of the units but if an experiment is to progress over some period of time it can be set up on the peripheral units, leaving the other tables free to serve as desks.

Laboratory experiences are used in three ways in the introductory physics course:

- I. To arouse curiosity and motivate students to inquiry.
- II. To compare measurements of the quantity made in two different ways.
- III. To test theory by making predictions and comparing them with measurements.

To introduce electric circuits, the student is given equipment which he does not understand, supposedly. A meter which gives a number after which you write "volts," a power supply that is used to control the number of volts, another meter which gives you a number called "amperes" and a resistance box on which you can dial a number. Systematically by holding one variable constant, the student varies the other two. By use of graphs, the student then attempts to find the relationships among the three variables: e.g., plot  $V$  vs.  $I$  and get a straight line the slope of which is  $R$ . Following this the student is given a black box which contains a diode, a capacitor, and some other non-linear device

to test "Ohm's Law." From this a discussion of emf, current, and resistance evolves.

To compare the results of measurements made in two different ways, the Atwood machine is used. One mass is dropped a measured distance and the time is measured.  $a = 2x/t^2$ . The difference in mass on each side of the pulley is measured from which  $a = (m_1 - m_2)g/(m_1 + m_2)$ . It is then possible to compare the acceleration of the mass,  $m_1$ , arrived at in two ways.

In developing the concept of vectors, the inclined plane is used. The class predicts the amount of mass on the mass hanger which will hold the cart on the "hill." Then the instructor adds or removes some mass and asks why the cart still doesn't move. Someone invariably mentions friction which leads to another discussion. After the concept is developed, the students in the class are required to determine the coefficient between their cart and plane by limiting angle of repose. After this the mass of the cart is measured. The student is then asked to predict the maximum and minimum amounts which will allow the cart to remain at rest on a plane inclined with the horizontal by  $10^\circ$ . Percent differences between predicted and measured results are calculated. Usually the percentage difference is less than 5.

By meeting in the laboratory it is possible to have lab experiences when they are most helpful or to have lectures demonstrated when these are most appropriate. With all the students together for every physics session, it is possible to develop a "group spirit" which is not possible with separate lab sections, if half of the group meets for one lab and the other half meets at another time. To foster the group spirit, the students are involved in taking measurements during demonstrations, or in recording the results of an experiment in tabular form on the chalkboard.

The students seem to appreciate this approach to physics teaching. When the students critique the course they state that "Physics is Fun," as advertized at UNA. Many say that it is difficult at times but even then it is fun.

The introductory physics students are making better grades now than when the separate lecture and laboratory sessions were held. The increase in good grades may be due to following a trend in higher education. Table 1 shows the grade distributions before and after the adoption of this technique.

Table 1. Grade Distributions in Introductory Physics Before and After Integrating Experience and Theory in Physics Teaching

	A	B	C	D & F
Before	14%	39%	40%	7%
After	24%	37%	17%	3%

## Experience and Theory in Physics Teaching

The final examination in this course consists entirely of multiple choice items. It is comprehensive and aims to test both grasp of physical concepts and problem solving ability. These tests are built from a large selection of test items which the author devised or which he inherited from Dr. E. Scott Barr when he retired. The tests are nearly equivalent. When the traditional method of teaching was used, the average grade on the final exam was 53%. Since integrating "lab and lecture," the average grade on the final exam is 59%.

Because of the current pressure on many departments for increasing class size, integrating experience and theory in teaching introductory physics may not be practical. In the experience of this author when the class size exceeds thirty, the efficiency of this approach to physics teaching falls off.

If the integration of experience and theory can be implemented, try it.

KOLB *VERSUS* OATES: THE ALABAMA GUBERNATORIAL ELECTION OF 1894

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While Alabama suffered from the effects of a severe depression and experienced the bitterness of a prolonged labor strike, the 1894 gubernatorial race opened a Pandora's box for the politically divided state. A political battle over the governor's office became a certainty when Governor Jones announced that he did not seek reelection. Moderate and conservative factions of the regular Democratic party--split chiefly over financial questions and represented, respectively, by Joseph F. Johnston and Congressman William C. Oates--soon fought for control of the party machinery in another of a series of divisive races for the Democratic gubernatorial nomination. Outside the ranks of the Democratic party, Reuben Kolb served as the candidate of several anti-Democratic groups and shaped an effective coalition supporting his candidacy of Jeffersonian Democrats, Populists, and Republicans. Kolb and his supporters, convinced that they had little hope for success if Democratic control of the election machinery continued unabated, concentrated on the issue of a free ballot and a fair count. Heavily Democratic returns from the black-belt and corrupt election practices produced a Democratic victory in 1894, but not before the state's voters had the chance to consider the issue of a free ballot and a fair count, the role played by blacks in the state government, and the questions--spawned by a massive labor strike--of the plight of the workingman, of labor's right to organize and strike, and of law-and-order *versus* anarchy.

The Alabama labor strike of 1894 was largely a product of the 1893 national depression, but the immediate causes were local. Soon after the national financial crisis began, a decrease in the demand for coal and iron produced sharp declines in the prices of both ores and caused Alabama mine operators to reduce production levels.<sup>1</sup> In June 1893, miners staged a strike to protest wage cuts announced by the Tennessee Coal and Iron Company, the largest mining corporation in the state. Although this initial strike was short-lived, similar strikes occurred throughout the summer of 1893. When rumors developed that the striking miners might attack the stockades that housed the convicts leased to the mining companies by the state, Governor Jones made preparations to use the state militia against the miners. Jones's preparations proved to be unnecessary, for most of the 1893 strikes soon failed due to a lack of organization among the miners. But continuation of both wage cuts and economic distress soon drove the miners together and made them easy proselytes for the organizers of the recently established United Mine Workers of Alabama. By January, 1894, the growing UMW had taken over the management of another strike that had developed in reaction to twenty-five percent wage reductions recently declared by the Woodward



Company, another large firm operating in the Birmingham mineral district. The UMW soon called similar strikes; but the mining companies forcefully opposed the union efforts at organization, used mostly black scab laborers and some convicts to maintain production, and soon broke the strikes.<sup>2</sup>

In April the UMW tried to force concessions from the companies by calling a statewide strike involving over six thousand miners. When the mine operators used scab laborers and convicts to maintain satisfactory production levels, many strikers talked of resorting to violence. In May violence erupted: a mine was dynamited, strikers exchanged shots with company guards, and Walter Glover, a black scab, was murdered near Birmingham. Governor Jones reacted by ordering three regiments of the state militia into the mineral district to prevent further violence; after a month of relative calm, the troops were withdrawn. Then in the first week of July Eugene V. Debs's American Railway Union strike came to Alabama. Before long new acts of violence plus the likelihood that transportation into the mineral district would be halted caused Jones to issue a statement denouncing the ARU strike and to send the state militia back into the area. After the ARU strike was crushed--largely due to Governor Jones's use of the state troops--the troops once more were withdrawn. Then on July 16 a large group of miners attacked some black scabs working at the Pratt Mines of the Tennessee Coal and Iron Company, killing three blacks and one company guard. The "Pratt Massacre" produced a wave of condemnation of the strikers from the Alabama press and forced Jones to order the troops back into the troubled area, where they stayed until mid-August. The strike continued until after the 1894 state election in August, when finally the striking miners--their resources exhausted, their unity crumbled, and their adversaries supported by the state government--had no choice but to accept the terms of the mine operators.<sup>3</sup> Because Governor Jones's actions stymied labor's efforts at organization and because the Democrats declared their opposition to labor's attempts to establish the right to strike, the strikers "held the Democrats politically accountable" in 1894 for the failure of the strike.<sup>4</sup>

Other political issues arose during Jones's second administration. Early in 1893, the Democrats in the General Assembly fulfilled the promise made in the thirteenth plank of the 1892 Democratic platform by introducing the Sayre Election Law bill. This bill became law despite strong opposition from Jeffersonians, Populists, and Republicans. Although the Sayre law was pictured as a means of disfranchising blacks, State Senator Albert T. Goodwyn--the leader of the Jeffersonians in the legislature--declared that the law would disfranchise 30,000 white voters; he described the Sayre law as "the most iniquitous measure that ever came through the portals of the Senate chamber."<sup>5</sup> It is clear that the Jeffersonians and Populists "did not oppose the disfranchisement of the Negro who was being used to 'outvote' the 'white' counties, but feared the [Sayre] law would disfranchise many of their illiterate white voters."<sup>6</sup> Opposition to the law also stemmed from the increased control over the election machinery it gave to the dominant party, which included empowering the governor to appoint local registrars. Moreover, the registration process--set during planting time under the new law--worked to the disadvantage of farmers. The process also could work to

the disadvantage of illiterates: the illiterate voter could have his ballot marked in secret by an election official, who might mark the ballot contrary to the directions of the illiterate.<sup>7</sup>

Another political battle occurred when Jones asked the legislature for a higher tax rate. The Governor claimed that the increase would protect the state's credit and prevent a drop in investments in Alabama's industries. But well-organized Jeffersonian opposition in the legislature forced Jones to make a strong stand in order to secure passage of the proposed tax rate increase. The combination of Jones's unpopular stand and the Jeffersonians' pleas not only for a low tax rate but also for cuts in governmental expenditures put the Governor and his party on the defensive.<sup>8</sup> The Democrats also suffered political setbacks for several other reasons: the effects of Jeffersonian attacks on a proposed school tax amendment, the criticism of Jones for pardoning Issac H. Vincent (a former state treasurer who had been convicted of embezzling \$250,000), the resentment generated by the failure of the legislature to pass the state elections contest law that Jones has promised in his second Inaugural Address, and the dissatisfaction spawned by the depression.<sup>9</sup> In regard to the question of the state government's role in meeting the economic crisis, Governor Jones said that the state government had no right or responsibility to become involved in the economic problems created by the depression; he therefore did nothing to alleviate the economic distress. Soon he was burned in effigy in Bessemer.<sup>10</sup>

Despite these signs of a lack of concern among Democratic leaders over popular support, Jones's second administration did not end without any Democratic moves to appease the state's voters. The Democrats not only pointed to the Sayre law as proof that they desired honest elections, they also charged the Sayre law's opponents with seeking to perpetuate corrupt election practices. Introduction of the proposed school tax amendment fulfilled an 1892 Democratic campaign promise to provide improved education for all races of Alabamians. Early in 1893 Democrats in the legislature sought to placate the workingman by passing an act that prohibited wage garnishments for any debts owed for taxes, rent, or food. At about the same time, the legislature passed an act (recommended by Governor Jones) which provided for reform of the convict-lease system: state convicts were to be removed from the mines sometime before January 1, 1895, but only if removal would not be detrimental to the financial interests of the state.<sup>11</sup>

These moves apparently had little effect: Governor Jones's popularity was at its lowest ebb in 1893 and rumors of his retirement in mid-term spread across the state. Yet the Jeffersonians and Populists realized that they had only a qualified chance for political success in 1894 because the Democratic party controlled the election machinery. To get an early start on the careful planning necessary to offset the Democratic advantage, the Jeffersonian and Populist state executive committees met jointly in Birmingham on May 11, 1893. Among those present were Reuben Kolb, Albert T. Goodwyn, J. C. Manning, P. G. Bowman, S. M. Adams, and Philander Morgan (the Populist brother of Senator John T. Morgan). Calls were issued for delegates to attend the 1894 Jeffersonian and Populist state conventions, both of which were scheduled for February 8 in Birmingham. As a basis for compromise with some elements of the

## Alabama Gubernatorial Election of 1894

Democrats, the Jeffersonian and Populist parties proposed jointly that a white primary--to be unaffected by the recent Sayre law limiting the suffrage--be held in April of 1894 to select the next Democratic state ticket.<sup>12</sup> This gesture toward compromise produced an uncompromising response: the Democratic State Executive Committee not only refused to accept the proposal but also declared that only those voters who had supported Cleveland in 1892 would be eligible to participate in future Democratic primaries. (Earlier the Democratic State Executive Committee--in response to longstanding criticism--had streamlined the method for holding local conventions and had established population as the basis for county representation in the next state convention.)<sup>13</sup>

When the Jeffersonian and Populist conventions convened in February in the same hall, they held both separate and joint sessions. Before the Populists agreed to accept the Jeffersonians' proposal for a joint session, the former adopted a platform and a list of resolutions denouncing the demonetization of silver by the federal government, the Sayre election law, and Democratic policy on the use of school funds. In their platform, the Populists went on record in favor of a free ballot, fair treatment of blacks, the creation of a separate state for blacks, and tax decreases.<sup>14</sup> Not all members of the People's Party supported the decision to meet with the Jeffersonians: a handful of Populists who felt that the Jeffersonians were too moderate on most questions opposed any degree of fusion with Kolb's party and mentioned Philander Morgan as a possible gubernatorial candidate on a "straight-out" Populist ticket.<sup>15</sup> Although one "straight-out" Populist newspaper had earlier gone so far as to call Kolb an unprincipled demagogue and a traitor to the ideals of American democracy, a large majority of Populists met with the Jeffersonians in a massive joint session involving over 1,500 delegates.<sup>16</sup> In the keynote address of the joint session, A. T. Goodwyn called for free and unlimited coinage of silver, a lower tariff, a graduated federal income tax, and a free ballot and a fair count. The combined parties then nominated Reuben Kolb for governor without opposition, whereupon the convention hall fell into pandemonium.<sup>17</sup> One impassioned Populist declared: "Kolb--the immortal Kolb! His name will go down with Washington's."<sup>18</sup> Many members of the convention crowd predicted that if Kolb could win in August his name would be on the 1896 Populist national ticket.<sup>19</sup>

After selecting a fusionist state ticket, the Jeffersonians and Populists devoted their energies to hammering out a platform and framing resolutions. Because the fair elections issue was uppermost in the minds of the delegates, it appeared in the platform as the demand for a state elections contest law and the call for "a free ballot and a fair count." Financial planks included demands for the free coinage of silver at a ratio of sixteen-to-one with gold, a circulating currency of fifty dollars per capita, a graduated federal income tax, and an end to "corporate control" of the circulating medium. One-third of the platform consisted of measures intended to attract the support of labor: a demand for the immediate removal of state convicts from the mines, a proposal that benefits of the lien laws be extended to miners, a pledge to enact a law stipulating that miners receive semi-monthly cash wages rather than company script, and a recommendation that children of less than thirteen years be prohibited from working in the mines. An ambiguous plank calling for a tariff "solely" for revenue *and* for limited protection was designed to appeal to Republicans.<sup>20</sup>

Conspicuously absent was the Negro rights plank of the 1892 Jeffersonian platform. This plank had favored protection of the political rights of blacks, improvement in the over-all condition of blacks, and better relations between the races. An incident at the 1894 convention symbolized the changes in outlook that had developed: William Stevens, the black Republican leader, entered the convention hall and interrupted a speech (being delivered by William H. Skaggs, ex-Mayor of Talladega) in an effort to address the joint meeting on behalf of his faction of the GOP; Skaggs denounced Stevens as an unprincipled rascal; the delegates cried for Stevens' expulsion, and the police had to be called upon to escort him safely from the hall.<sup>21</sup> Earlier the Jeffersonian and Populist state executive committees in effect had proposed disfranchisement of blacks when they called for a white primary. Obviously they did not intend to bid for the black vote as openly as they had done in 1892.

For several reasons in addition to the cooperation between the Jeffersonians and the Populists, the Democrats faced stronger opposition in 1894 than in 1892. Growth of the Jeffersonian party had been stimulated by their winning control of many local offices and a small amount of patronage. Most observers agreed that in 1894 Kolb commanded a well-organized statewide political machine second in strength only to the Democracy. The Populists were also stronger; in some counties they even outnumbered the Jeffersonians. Although the two groups retained their separate state organizations throughout the 1894 race ("straight-out" Populists only reluctantly agreed to support Kolb's party), the two parties were virtually one.<sup>22</sup> The coalition promised to be hard to defeat.

While the Democrats became enmeshed in what threatened to be a very divisive nomination race, Kolb began campaigning actively. He criss-crossed the state, warning that the Sayre law would disfranchise poor whites and charging that Democratic frauds had prevented him from taking office as governor in 1892. On the Democratic side, Joseph F. Johnston, Birmingham banker and perennial gubernatorial candidate, became the first Democrat in the race when he announced his candidacy as a free silver Democrat representing those members of his party dissatisfied with Cleveland's financial policies. Johnston said his goal was "to build and not to destroy, to bring peace, and to unite our party once more."<sup>23</sup> He declared his intentions to bring about many reforms, but claimed that "all the reforms and all the remedies we are seeking are easier to accomplishment inside the ranks [of the Democratic party] than outside."<sup>24</sup> Johnston had the support of Senator Morgan and the largest Birmingham papers--the *News* and the *Age Herald*.<sup>25</sup> Johnston's opponent for the nomination was Congressman William C. Oates, the one-armed Confederate hero from Henry County. Oates, a staunch conservative, had been a constant enemy of the Farmers' Alliance when that organization was stronger. When he endorsed President Cleveland and opposed free silver, this made clear the lines of division in the Democratic party. Congressman Oates enjoyed the backing of Governor Jones and the Montgomery *Advertiser*.<sup>26</sup>

In their battle for delegates to the state convention, both Democratic gubernatorial candidates campaigned throughout the state and expressed confidence in an easy victory. Because of the two candidates'



divergent financial views, one might have expected the free silver question--which Oates's forces viewed as a measure designed to confuse the voters--to become the test of a man's Democracy. But endorsement of Cleveland became the major issue. The *Advertiser* focused attention on this question when it declared that Johnston was "medium soft on Populites, and at best only lukewarm in favor of endorsing Cleveland's administration."<sup>27</sup> Despite Johnston's success in attracting significant support in North Alabama counties that had gone for Kolb in 1892 and despite predictions of Oates's withdrawal, the closeness of the race soon forced Johnston to give President Cleveland a firm endorsement in order to ward off the *Advertiser's* criticisms.<sup>28</sup>

The Democratic State Convention met May 22 and completed its work in a single day. Oates was nominated on the first ballot, obtaining 271 votes to Johnston's 232.<sup>29</sup> Johnston felt that the nomination had been stolen from him, but pledged nevertheless to support Oates.<sup>30</sup> Once Oates had been nominated and Democratic party unity had been restored, the conservative faction showed a willingness to retreat from the Bourbon philosophy that the party had embraced in recent years. Portions of the Democratic platform made clear this change: the Democrats not only expressed support for the free coinage of silver--*if that policy would not endanger a safe and sound currency*--but also went on record in favor of repealing the ten percent federal tax on state bank notes; they also called for continued efforts to end the evils of the convict-lease system; in addition, the Democrats advocated new laws to prevent injustice to any class of people.<sup>31</sup>

Once they had completed their party business, the Democrats entered the 1894 political struggle in earnest. They rapidly put Kolb on the defensive by charging that he had forged an agreement with the Republicans in 1892: the Democrats claimed not only that Kolb had made a deal concerning Alabama's electoral votes but also that he planned to hand over control of Alabama to the GOP in 1894.<sup>32</sup> Although Kolb had made the electoral vote bargain with the Republicans, Kolb's supporters called the Democrats' charges "silly twaddle."<sup>33</sup> The Democrats also attacked Kolb's stand on the tariff: because on several occasions Kolb had advocated a protective tariff, his attempt to "hitch the farming population of Alabama to the high tariff coach of the East" was called madness; the Democrats also claimed that Kolb's "tariff madness" exposed his true Republican character.<sup>34</sup> Despite the apparent viability of the tariff issue, neither Kolb nor the Democrats gave much additional attention to the question. Kolb's response to the attack on his "tariff madness" contained nothing substantive: "I can stand any name--Republican, Populist, Jeffersonian, or anything else--except a democrat. Do not call me a Democrat."<sup>35</sup>

Damaging to Kolb's chances was the controversy over alleged Republican contributions to his campaign. Earlier in the year, Kolb had met with Republican Senator George F. Hoar of Massachusetts to discuss the possibility of defeating the Democrats in Alabama.<sup>36</sup> After Hoar found Kolb's views on a protective tariff to be acceptable, he wrote a letter to the Home Market Club of Boston suggesting that campaign funds be raised to aid Kolb.<sup>37</sup> The Hoar letter soon appeared in Democratic papers in Alabama, accompanied by statements claiming that Kolb had

received \$50,000 in campaign funds from the Home Market Club.<sup>38</sup> Although the Montgomery *Alliance-Herald* declared that the Hoar letter charges were absurd, the Troy *Jeffersonian* said that it welcomed all contributions to the fight against the Democrats.<sup>39</sup> In the opinion of one Democrat, the episode proved that Kolb was plotting to return Alabama to Radical Republican rule.<sup>40</sup>

Although Kolb probably received little--if any--financial support from the GOP, Kolb's Jeffersonians cooperated closely with the Republicans during the 1894 campaign. They had a common goal--to defeat the Democracy. They could unite on the fair elections issue. Kolb helped create an atmosphere favorable to cooperation by favoring Republican ideology on a protective tariff. But even before the Jeffersonian convention, the Montgomery *Advertiser* had predicted that the GOP would back the Jeffersonian candidates.<sup>41</sup> During spring of 1894, the Republican group led by GOP state boss Robert A. Moseley, Jr., had fulfilled the *Advertiser's* prophecy by endorsing Kolb.<sup>42</sup> Later the Moseley faction got the Republican State Convention not only to endorse Kolb but also to forego nominating GOP candidates for state offices.<sup>43</sup> These actions caused William H. Smith, the Radical Republican Governor of Alabama during Reconstruction, to declare that Kolb would receive ninety percent of the Republican vote.<sup>44</sup> While the Republicans contributed significantly to Kolb's cause, the Jeffersonians in turn supported local GOP candidates in a few heavily Republican North Alabama counties.<sup>45</sup> The Stevens Republicans, however, ran a separate state ticket and gained the support of many other Republicans who refused to cooperate with Kolb's forces.<sup>46</sup> Stevens, himself, endorsed Oates!<sup>47</sup>

The labor strike added to the election year tumult and gave rise to a number of political issues, the most important of which was the question of law-and-order *versus* anarchy. Numerous acts of violence in the mineral district produced an aura of lawlessness that generated fear in the minds of many Alabamians. The Democrats took advantage of the climate by planting in the frightened voters' fertile minds this slogan: "A vote for Kolb is a vote for the perpetuation of unrest in Alabama."<sup>48</sup> Putting things in clear terms of law-and-order *versus* anarchy, the Montgomery *Advertiser* said: "if you want riots, lawlessness, turmoil and feuds vote for Kolb. If you wish peace, respect for law and order, good government, and prosperity vote for Oates."<sup>49</sup> Fearing an increase in radicalism if Kolb were elected, many professional men--merchants, bankers, and lawyers--announced that they had heard enough to convince them to support Congressman Oates.<sup>50</sup> Not content with merely that development, the Democrats continued to harp on the same theme by comparing Kolb with Eugene V. Debs and by accusing Kolb of favoring the recent murder of a Monroe County law enforcement officer.<sup>51</sup> Kolb's followers were charged with stirring up labor, prolonging the strike, and committing acts of violence.<sup>52</sup> And the Birmingham *Age-Herald* published the following description of the Jeffersonians:

men spewed out of their old party, men who have failed in business and politics; fanatics, [the] brood of ignorance and prejudice; every bridge burner and midnight torch bearer; old carpet baggers and scalawags, rising up and sniffing the prey again; every anarchist and socialist; every man whose lean and clammy fingers are itching for the contents of other people's pockets.<sup>53</sup>

## Alabama Gubernatorial Election of 1894

Other issues linked to the labor unrest soon came into focus, including the use of state troops during the strike and the existence of the convict-lease system. The Jeffersonians criticized Governor Jones's use of the troops, ridiculed "Tommie Jones and his tin soldiers," and accused him of promoting clashes between the troops and the strikers. William H. Skaggs, Chairman of the Jeffersonian-Populist Central Campaign Committee, declared that the Governor had overstepped the bounds of his authority when he called out the state troops. Kolb's forces warned that Jones's actions revealed a trend toward the establishment of total militarism in Alabama, with troops soon to accompany farmers into their fields.<sup>54</sup> Although even some Democrats condemned Jones for using the troops, most members of the Governor's party defended his actions as necessary to preserve law-and-order and to protect property.<sup>55</sup> In another campaign offensive, Kolb's supporters tried to capitalize on labor's discontent by demanding the immediate removal of state convicts from the mines, but they failed to emphasize the issue. This was probably because the Democratic promise to end the evils of the convict-lease system neutralized the Jeffersonian's statements on that question--except among the miners. An added reason for avoiding the issue might have been to prevent further attention from being given to the Democrats' interpretation of the Jeffersonian demand for immediate removal as a plan for turning the convicts loose in order to make room in the mines for foreign anarchists.<sup>56</sup>

The miners, who often displayed more interest in the campaign than in their own 1894 strike, supported Kolb and the Jeffersonian party. Because the miners regarded Governor Jones as the leader of the interests that originally had placed the convicts in the mines, they ignored his overtures on the convict-lease issue. Their intransigence toward the Democrats was increased as a result of the miners' view that the mine operators' hiring of black scabs in effect constituted Democratic protection of blacks. The miners' feelings were reflected in the actions of a convention of labor leaders held during March: the convention endorsed Kolb and the Jeffersonian platform, and also selected local labor candidates to run on the Jeffersonian ticket. Then on June 18 a mass meeting of miners voted unanimously to back Kolb and his party.<sup>57</sup> In the final week of the campaign, J. R. Sovereign, Grand Master Workman of the Knights of Labor, spoke in Birmingham for Kolb and the Jeffersonians. Sovereign claimed that if Oates won the 1894 election striking miners would be shot down by state troops acting on Oates's orders.<sup>58</sup> The miners' reaction to such statements caused one of Jones's associates (who was in an excellent position to know) to declare privately that the miners would give Kolb his strongest support.<sup>59</sup> Perhaps on the basis of such declarations, the Democrats discounted the labor vote. The Democrats not only alleged that the perpetrators of the "Pratt Massacre" and other acts of violence against black scabs were all "Kolbites," but also declared that both miners and blacks could not be in the same political camp.<sup>60</sup> With the implication that the blacks would support the Democrats, the *Advertiser* announced that Kolb had no hope of attracting black support.<sup>61</sup>

In addition to the labor dissatisfaction occurring during Jones's second administration, Cleveland's second administration also produced problems for the Democratic party in Alabama. Although many Democrats



in the state praised Cleveland and most endorsed his administration, Populists across Alabama and the nation used the President's rising unpopularity as a catalyst in their formula for precipitating growth of the People's Party. Thousands of laborers resented Cleveland's use of federal troops during the 1894 Pullman strike. Because Cleveland failed to give a satisfactory explanation of his bond issues and his support of the gold standard, thousands of anti-Cleveland voters gained greater conviction in their belief that he was involved in a conspiracy with "monied interests." When Cleveland blamed the 1893 depression on the Sherman Silver Purchase Act of 1890 and then obtained its repeal, the President embittered the multiplying number of free silver advocates. His financial policies were called a "sell-out" to the "gold bugs" of Wall Street and his actions led the Jeffersonians in Alabama to label him "an image of debauchery" comparable to Nero.<sup>62</sup>

After 1892, financial issues raised during Cleveland's second administration--especially the free silver issue--began replacing agricultural issues as the chief concern of the People's Party. During this time, the Populists became closely associated with western silver mining interests--a source of desperately needed campaign funds. Before long such agricultural planks as the demand for prohibitions against dealing in agricultural futures--a major goal of the farmers--disappeared from the Populist national platform, and financial planks predominated.<sup>63</sup>

Kolb and his party sought to capitalize on the financial issues. Both the Jeffersonian and Populist platforms contained free silver planks. In addition, Kolb proclaimed that the free coinage of silver would solve many of the farmers' economic problems.<sup>64</sup> Even Senator Morgan, who had his ear closer to the ground than many Democrats, endorsed free silver and condemned Cleveland's financial policies. But many Democrats preferred to side-step free silver by giving it nothing more than qualified support.<sup>65</sup> The Democratic press, however, announced that free silver should have no bearing whatsoever on the state race.<sup>66</sup> And Congressman Oates, a sound money advocate, avoided making a clear statement on the question, although his supporters told free silverites that he had introduced a free silver bill in Congress.<sup>67</sup> The *Troy Jeffersonian* countered by alleging that the "*Advertiser* and Col. Oates are so wedded to the interest of the money power; and so firmly fastened to the Cleveland ring that they have quit thinking for themselves."<sup>68</sup> Not only did the Montgomery *Advertiser* defend Oates from this attack and similar attacks (including one that he was financing his campaign with British gold), the *Advertiser* also defended him from the charge that he had received a \$100,000 bribe from the Sugar Trust in return for his support of congressional legislation favorable to the "money power."<sup>69</sup> But many other questionable Jeffersonian allegations came to light during the campaign. For example, William Skaggs spread the rumor that Oates had proposed a law designed to imprison debtors.<sup>70</sup> And the *Troy Jeffersonian* sank to absurdity in its maligning of Oates, calling him a "cuckoo of the first water."<sup>71</sup>

With regard to the question of education, Oates clearly found himself on the defensive. Although the Jeffersonian stance on education was questionable in view of their opposition to the recent school tax amendment proposed by the Democrats, the Jeffersonians demanded a strong

policy to increase educational opportunities for the masses. Kolb was applauded for championing the cause of better education, while Oates was criticized for saying not only that the masses would suffer from too much education but also that ninety percent of the blacks were incapable of progressing past the primary grades.<sup>72</sup> Oates tried to explain: he supported education for the masses, but thought that only the primary grades would be beneficial to the majority.<sup>73</sup> Yet Kolb's forces still made political hay of the Congressman's unfortunate statements.

From the standpoint of the Jeffersonians, no issue had more political significance than the problem of fair elections. "It is useless for us to talk about the money question, about taxation, or about education," declared the *Troy Jeffersonian*, "for we can have no voice concerning any of these questions until we have the right to cast our vote as we please and have it counted as cast."<sup>74</sup> Kolb's followers shared a recognition of the urgency of the campaign: one anti-Democratic paper even called the election the most critical period in American history since the revolutionary era.<sup>75</sup> "If we fail to free ourselves from the bossism of unprincipled demagogues in 1894," declared the Albertville *Sand Mountain Signal*, "we shall never be anything but hewers of wood and drawers of water."<sup>76</sup> The *Troy Jeffersonian* warned that "if relief for the masses does not come through equitable laws it will come through revolution."<sup>77</sup> With "Ballots or Bullets" as their slogan, Kolb and the Jeffersonians sought to "redeem the state from the clutches of the machine that had governed it for so long."<sup>78</sup>

The Jeffersonians' emphasis of the fair elections issue was related to their belief that they were striving not only to preserve American Democratic ideals but also to save the downtrodden masses from domination by a privileged group. Because Oates's opponents feared that if elected governor he might limit freedom of speech, they criticized him and his party for their alleged intolerance of different viewpoints.<sup>79</sup> Even such a prominent Democrat as future governor Emmet O'Neal privately expressed his opinion that the machine protected corporate interests and ignored the people's rights.<sup>80</sup> Populist leader Joseph C. Manning, convinced that society had failed to live up to his ideals, wrote these words:

The common people always fight all the battles in times of war, create all the wealth in periods of peace; but, whether in the battle of blood or the struggle for bread, they have never reaped a substantial benefit from either contest. They have been engaged in a prolonged, though varying struggle, all down the history of the ages, and greed and avarice have always sapped their energies and sucked their life-blood.<sup>81</sup>

At the same time, Manning expressed his sadness over the "life of the average Alabamian, who . . . , after years of toil, privation, and endurance, approaches the verge of eternity unable to bequeath a heritage of neither full-fledged liberty nor [*sic*] free-titled land to uneducated, homeless, and hopeless children."<sup>82</sup>

Discussion of the fair elections issue focused on the Sayre election law and on charges of political corruption. Jeffersonian speakers

maintained that the law not only disfranchised 40,000 white voters but also increased Democratic control of the election machinery.<sup>83</sup> The Jeffersonians even claimed that the Sayre law was so stringent that it disfranchised Congressman Oates.<sup>84</sup> "The farmer who votes the Organized ticket," declared the Albertville *Sand Mountain Signal*, "votes for disfranchisement of himself and his family."<sup>85</sup> On the other hand, the Democrats maintained that the Sayre law would end Jeffersonian election frauds and allow illiterates to cast an honest ballot.<sup>86</sup> Oates answered the charges that he sought to disfranchise some Alabama voters by declaring that the only group he favored disfranchising was ignorant foreigners.<sup>87</sup> Apparently Kolb and his supporters thought that the corrupt elections issue outweighed the disfranchisement issue, because they devoted virtually all of their attention to the question of Democratic election frauds.<sup>88</sup> In North Alabama where secession and the Civil War had been unpopular, the Jeffersonians accused the Democrats of committing frauds in the election of delegates to the 1861 Alabama secession convention.<sup>89</sup> The Butler *Choctaw Advocate* referred to more recent elections when it said: "the name of Tom Jones [will] be a synonym in the future for one of the vilest political robberies ever inflicted upon the state of Alabama."<sup>90</sup> On June 16 Jeffersonians issued a statement charging the Democrats with planning to steal the 1894 election by resorting to corrupt methods: padding registration lists, refusing to permit examination of the lists, issuing fraudulent registration certificates, bribing voters, and failing to provide for bipartisan election inspectors.<sup>91</sup> The Jeffersonians also alleged that the manipulation of black votes continued to be the basis of Democratic power; fraudulent black votes, said Kolb's supporters, permitted the Democrats to rule a white majority in Alabama.<sup>92</sup> The Jeffersonians boldly proclaimed that the voters would not submit any longer to such outrages: "They are demanding, and, in the name of God and humanity, *will have* a free and fair expression of their political will on the rostrum and at the polls."<sup>93</sup> The Democrats countered by accusing the Jeffersonians of preparing to commit election frauds and by alleging that Kolb's followers had threatened to shoot or hang the election managers if the count went against Kolb.<sup>94</sup> Yet the Democrats threatened to count out Kolb even if he had a 75,000 vote majority.<sup>95</sup>

Democratic control of both the election machinery and the black vote produced readjustments in the Jeffersonian position on Negro Rights since the 1892 campaign. Protection of the political rights of blacks had been one of the announced goals of Kolb's party in 1892, and the Jeffersonians had appealed to the blacks for support on the grounds that defeating the Democrats would be in the best interests of the blacks. But by the time of the 1894 campaign, the Jeffersonians believed that ballot freedom for blacks could not be achieved. Therefore an increasing number of Kolb's supporters favored either black disfranchisement or some other method for preventing Democratic use of black votes.<sup>96</sup>

Yet even if Kolb's party had tried to cooperate with blacks, there was no basis for a Jeffersonian-Negro Alliance in Alabama. In cases where cooperation between agrarians and blacks was attempted and failed, the reasons for failure cited by historians have been race prejudice, Democratic election frauds, and black votes cast for the Democracy.<sup>97</sup> It is noteworthy that only the last of these reasons recognizes an

active role played by blacks in failure. Although mutual self-interest has been pointed to as the stimulus for agrarian overtures to the Negro, blacks and whites did not share a common conception of self-interest. On the other hand, "the promises and doctrines of Populist ideology were antithetical to Negro experience."<sup>98</sup> One historian has said that blacks wanted protection and patronage, while the agrarians had goals which were basically economic.<sup>99</sup> Yet without adopting agrarian ideology, blacks might have supported the Jeffersonians in return for protection and patronage. After 1892, however, the Jeffersonians offered the blacks very little protection and no patronage: there is no evidence that blacks held any offices in the Jeffersonian party, and Kolb's followers actually excluded blacks from participation in the 1894 Jeffersonian-Populist convention.<sup>100</sup>

Agrarian political positions that could have attracted black votes in 1894 concerned fair elections, the convict-lease system, and education.<sup>101</sup> But closer examination reveals reasons why these issues might not have appealed to blacks in Alabama as much as expected. The Jeffersonians' emphasis of the fair elections issue stemmed from their desire to increase the power and effectiveness of white votes, not from their desire to protect the voting rights of blacks. In addition, blacks looked with extreme suspicion on Populist demands that a secret ballot be adopted.<sup>102</sup> The convict-lease issue, which appealed to blacks far more than the fair elections question, lost some of its clout as a result of the Democratic stand on the issue and of the Jeffersonian associations with free white labor. And while Kolb's followers put Oates on the defensive on the education issue, the Jeffersonians favored segregated schools and advocated splitting up the school funds on the basis of the amount of taxes paid by each race.<sup>103</sup>

The agrarians have been credited with offering alternatives to the later pattern of southern racism because of their views on lynching, jury service, and black civil rights.<sup>104</sup> Yet before 1896 no southern agrarian political platform came out against lynching.<sup>105</sup> During the 1894 election, White-Caps--organized groups of whites who sought to intimidate blacks--appeared in many pro-Kolb counties in Alabama, and some of Kolb's supporters were reported to be busy threatening blacks who favored Oates.<sup>106</sup> Although the agrarians did condemn lynching, they did so in about the same manner as Democrats.<sup>107</sup> The Jeffersonians apparently did not differ from the Democrats on the matter of black office-holding. No evidence exists that a single black served on any jury in any Alabama county controlled by the Jeffersonians or the Populists. In addition, the Alabama agrarians supported the state's Jim Crow laws of the 1890s.<sup>108</sup>

In 1894 the Jeffersonians made white supremacy an issue. They declared that the Democrats had to be defeated in order to preserve white unity and to prevent black rule in Alabama.<sup>109</sup> A. T. Goodwyn warned that Democratic dependence on black votes would force the Democrats to bring blacks into the center of political life.<sup>110</sup> Some of Kolb's supporters accused the Democrats of appointing blacks to numerous political offices. (But Kolb's party tried to avoid letting the blacks know of this accusation.)<sup>111</sup> At the same time, Oates's forces--now called the "Radicals" by the *Troy Jeffersonian*--were maligned for seeking black votes and were charged with organizing leagues of black voters similar to those

sponsored by the Radical Republicans during reconstruction.<sup>112</sup> The Jeffersonians also claimed that fraudulent black votes would be used in 1894 as they had been used in 1892 to defeat Kolb.<sup>113</sup> A North Alabama Allianceman expressed the opinions of many agrarians on the Democratic party's use of black votes when he wrote:

Why, those blackbelters wouldn't part with their negro vote for anything in the world--it is their all in a political way. They grow fat on negro votes. But, don't forget it, they keep us white people powerful lean by the use they make of their negro army.<sup>114</sup>

For most Jeffersonians, the solution to the problem of black votes was simple: remove the blacks from politics. The Troy *Jeffersonian* reflected this sentiment when it warned that "the best thing for the negro voter to do in the coming registration and election is to keep hands off and let the white voters settle the matter between themselves."<sup>115</sup> One Kolb partisan advocated "shooting every damned negro who offers to vote."<sup>116</sup> Yet in the counties that they controlled, the Jeffersonians tried to register blacks.<sup>117</sup> To offset this effort, the Moseley Republicans distributed throughout fifteen black-belt counties copies of a circular signed by Robert Moseley that urged blacks not to register or vote.<sup>118</sup> W. H. Skaggs, commenting on the success of the Moseley Republicans' effort, estimated that only five percent of those blacks eligible to vote would actually register.<sup>119</sup>

At the same time, the Democrats' need for black votes forced them to appear moderate on the race issue in contrast to their previous pronouncements. The Democracy, however, still claimed to be the party of white supremacy and tried to portray the Jeffersonians as a dangerous band dependent upon black votes.<sup>120</sup> Democratic newspapers still alleged that Kolb's supporters were saying: "Vote the negro is our motto, and elect Kolb is our aim."<sup>121</sup> The Montgomery *Advertiser* still claimed that Kolb's men "are driving the negroes to the registration boxes like sheep."<sup>122</sup> But in contrast to the situation in recent elections, there occurred a significant change in the nature and intensity of racist rhetoric now used by the Democrats. The Democratic party now sought to attract the votes of the "better class" of blacks, causing the Birmingham *Age-Herald* to announce: "The negroes are supporting Oates and the 'niggers' Kolb."<sup>123</sup> One contemporary later declared that the "colour line seemed to have broken down" in Alabama, but Kolb's party did not force the Democrats to adopt as moderate a position as that of the Democrats in Georgia--where Tom Watson's agrarian contingent was making a strong bid for black votes. One reason for this was because Kolb's supporters included persons with widely different attitudes toward blacks: J. C. Manning favored a strong defense of black political rights, while some of Kolb's associates actually had reputations as repressors of black rights.<sup>124</sup> Kolb apparently "equivocated on a rapprochement with the Negro and from time to time let a strong strain of antipathy for the Negro erupt which made Negroes hesitant to support him."<sup>125</sup>

Perhaps this explains why the blacks responded to the Democrats' strong appeals for black votes by giving them their support. After a



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meeting in Birmingham, black leaders published a letter calling for equal protection of blacks before the law, equal and separate accommodations on the state's railroads, and equal employment opportunities for qualified blacks. When H. C. Tompkins, Chairman of the Democratic State Executive Committee, declared his approval of the blacks' demands, the black leaders endorsed Oates.<sup>126</sup> A black convention soon convened to discuss the respective positions of Kolb and Oates on the Negro: the delegates first announced that the Democrats promised to enact laws beneficial to blacks that Kolb's party refused to consider; then they voted unanimously to endorse Oates.<sup>127</sup> Throughout the state, Democratic speakers told black crowds that Oates would protect them from mob violence and uphold equal protection before the law for all people.<sup>128</sup> With some apparent justification, Oates not only accused Kolb of seeking to use black votes but also warned the blacks that race relations would deteriorate if Kolb were elected.<sup>129</sup> The Birmingham *News* kept up the pressure by advocating equal justice for blacks and labeling Kolb a foe of the black race.<sup>130</sup> These statements apparently convinced many blacks that their best chance for racial moderation lay with the Democrats, because many local black politicians, lawyers, ministers, teachers, and editors gave their support to Oates.<sup>131</sup>

As the campaign approached the election-day climax, Kolb and Oates debated the issues at Salem in late July before a crowd of two thousand. Each spoke for about two hours. Kolb rehearsed the fraud charges, castigated the Sayre election law, advocated a limited protective tariff, charged Oates with gaining the Democratic nomination by trickery, and claimed that Senator Morgan and many other Democrats favored the Jeffersonian platform. Oates emphasized Kolb's associations with Republicans and Populists and warned that Kolb meant to return Alabama to Radical Republican rule.<sup>132</sup>

Even more bitterness was evident in the 1894 campaign than the hotly-contested 1892 election. In June, P. G. Bowman killed a Democrat in a brawl started by a political argument.<sup>133</sup> Before dinner was served at an Alliance barbecue, the guests were told: "If you are Kolb men you are welcome; if you are Oates men you cannot eat our meat and bread. You can sneak off--you can't eat our bread and meat."<sup>134</sup> When a Tuscaloosa store clerk declared that "every damn man who [votes] for Kolb in the coming election ought to go to hell," his store was boycotted by Kolb's supporters.<sup>135</sup> In clashes on school grounds, children defended the honor of their champions.<sup>136</sup> Kolb was called a traitor, a liar, a thief, a radical, and a "drunk, not on liquor, but on a blind ambition to be Governor of Alabama." Oates was labeled an infidel, "an adulterer" [*sic*], and a child-molester.<sup>137</sup> Bands of armed "Kolbites" drilled as if preparing for war and threatened violence if the election were not conducted fairly.<sup>138</sup> Peace usually prevailed on election day, the sixth of August, but an atmosphere of tension and rumors of stolen ballot boxes precipitated a few clashes between Kolb and Oates men.<sup>139</sup>

Returns coming in the day after the election, and for the next three days, indicated a Democratic victory. The official count gave Oates 109,547 votes and Kolb 84,602. Oates's margin of victory--almost 25,000 votes--resulted from overwhelming Democratic majorities in a handful of black-belt counties. In Dallas County, Oates received 6,517

of 6,684 votes counted; in Wilcox County he picked up 6,270 of 6,401; in Montgomery County 4,930 of 5,210, and in Lowndes County 4,995 of 5,356.<sup>140</sup> Outside the black-belt, Oates's greatest support came from the towns, where he captured as much as eighty-nine percent of the vote.<sup>141</sup>

On August 7 Kolb announced that he would appeal the results of the election to the people. "I have carried forty out of fifty-one white counties," he declared. "I have been elected with the entire state ticket by a majority of not less than 18,000."<sup>142</sup> Although he admitted his total vote had declined since 1892, Kolb cited instances of widespread Democratic corruption as proof that Democratic "frauds of this year are more notorious and shameful than those of 1892."<sup>143</sup> After meeting two days later to discuss the situation, Kolb's supporters issued a statement claiming a Jeffersonian victory in the recent election and accusing the Democrats of fraud.<sup>144</sup> The *Troy Jeffersonian* said: "There is no question that the Sayre law has proven a better instrument of fraud in elections than the old law."<sup>145</sup> But the Democrats maintained that the law had been responsible for a very clean election.<sup>146</sup> Kolb men circulated a call for vigilante groups to form and converge on county courthouses on the day of the official count of the votes to force an honest tally of the ballots.<sup>147</sup> Talk was heard throughout the state of the establishment by force of a provisional Jeffersonian government to replace the Democrats.<sup>148</sup>

Because Alabama lacked a contest law applying to state elections, Kolb tried to interest his Republican friends in an alternate method for challenging the victorious Democrats. In letters to Senator William E. Chandler of New Hampshire, Kolb not only said he was "prepared to show up greater frauds than in the election of 1892" but also proposed establishing a Jeffersonian state government with a legislature pledged to elect a United States Senator devoted to a policy of tariff protection for American industry.<sup>149</sup> Chandler soon tried to introduce a resolution in the United States Senate calling for an investigation of the recent Alabama elections to determine if the new legislature had been honestly elected and if it could rightfully select a Senator.<sup>150</sup>

Prior to the first meeting of the new legislature in November, Kolb's political allies--led by A. T. Goodwyn--met to discuss possible methods for seating Kolb, but they failed to adopt a definite plan of action. However, those Jeffersonians present voted to join the People's party, and in future elections the dissident groups in Alabama were united as Populists. After the legislature convened, Goodwyn challenged the official election returns for fifteen black-belt counties. This protest had no chance of being considered by the predominantly Democratic legislature, and it was ruled out-of-order.<sup>151</sup>

Kolb still refused to acknowledge defeat. He reiterated his claim that he had been elected and declared: "I shall be in Montgomery for the purpose of taking the oath of office and my seat as governor."<sup>152</sup> On the first day of December, Oates was inaugurated in a brief ceremony conducted on the steps of the capitol in Montgomery.<sup>153</sup> Later the same day Kolb took the oath of office astride a wagon a few blocks from the capitol. In a short address, Kolb said: "I promise . . . to use all legal means at my command to set aside the fraudulent election returns



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by which Colonel Oates claims the office of governor."<sup>154</sup> For a few weeks, Kolb tried to keep his pledge by sending message to the new legislature demanding that he be recognized as the legitimate governor. His messages were ignored.<sup>155</sup>

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<sup>20</sup>*Montgomery Advertiser*, February 9, 1894.

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- <sup>86</sup>Democratic Party Campaign Committee, *Democratic Campaign Book*, pp. 14-16; Northport *West Alabama Breeze*, July 12, 26, 1894.
- <sup>87</sup>Democratic Party Campaign Committee, *Democratic Campaign Book*, p. 10.
- <sup>88</sup>Robert Saunders, "Southern Populists and the Negro, 1893-1895," *Journal of Negro History*, LIV (1969), p. 245.
- <sup>89</sup>Manning, *Politics of Alabama*, p. 22.
- <sup>90</sup>Butler *Choctaw Advocate*, May 17, 1893, quoted in Huggins, "Bourbonism and Radicalism," p. 302. Jones was threatened with assassination if the 1894 elections were unfair. See: Birmingham *Age-Herald*, December 13, 1893.
- <sup>91</sup>Montgomery *Advertiser*, June 16, 1894.
- <sup>92</sup>Troy *Jeffersonian*, March 16, June 15, 1894.
- <sup>93</sup>Manning, *Politics of Alabama*, p. 36. The Troy *Jeffersonian*, May 4, 1894, declared that many Democrats, fed up with the corruption of their party, were supporting Kolb.
- <sup>94</sup>Montgomery *Advertiser*, August 4, 1894; Birmingham *Age-Herald*, August 4, 1894. One Democratic paper reported that Kolb admitted stuffing ballot boxes in Barbour County during the redemption campaigns of the mid-seventies. See: Northport *West Alabama Breeze*, July 26, 1894.
- <sup>95</sup>Troy *Jeffersonian*, August 3, 1894.
- <sup>96</sup>Montgomery *Advertiser*, June 10, July 26, 1892; Troy *Jeffersonian*, March 2, 1894.
- <sup>97</sup>William H. Chafe, "The Negro and Populism: A Kansas Case Study," *Journal of Southern History*, XXXIV (1968), pp. 402-403.
- <sup>98</sup>*Ibid.*, p. 416.
- <sup>99</sup>*Ibid.*, pp. 404, 416, 418.
- <sup>100</sup>Birmingham *News*, February 9, 1894; Montgomery *Advertiser*, February 9, 1894.

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- <sup>101</sup>Saunders, "Southern Populists and the Negro," p. 242.
- <sup>102</sup>*Ibid.*, p. 243.
- <sup>103</sup>*Ibid.*, pp. 243, 245; Thomas Goode Jones, "The 1890-92 Campaigns for Governor of Alabama," *Montgomery Advertiser*, September 17, 1911, reprinted in *Alabama Historical Quarterly*, XX (1958), p. 672.
- <sup>104</sup>Saunders, "Southern Populists and the Negro," p. 245.
- <sup>105</sup>*Ibid.*, p. 248.
- <sup>106</sup>*Montgomery Advertiser*, April 3, July 22, 1894.
- <sup>107</sup>Saunders, "Southern Populists and the Negro," pp. 248-249.
- <sup>108</sup>Sheldon Hackney, *Populism to Progressivism in Alabama* (Princeton, N.J.: Princeton University Press, 1969), pp. 45-46.
- <sup>109</sup>Hearn, "Populist Movement in Marshall County," pp. 71-73; *Montgomery Advertiser*, June 7, 1894; *Albertville Sand Mountain Signal*, May 25, 1894, quoted in Hearn, "Populist Movement in Marshall County," p. 85.
- <sup>110</sup>Summersell, "Reuben F. Kolb," pp. 100-101.
- <sup>111</sup>*Northport West Alabama Breeze*, July 12, 1894.
- <sup>112</sup>*Troy Jeffersonian*, June 15, August 3, 1894.
- <sup>113</sup>*Ibid.*, March 16, 1894; Manning, *Politics of Alabama*, p. 35; Ward and Rogers, *Labor Revolt in Alabama*, p. 125. The *Troy Jeffersonian*, June 15, 1894, credited Kolb with a 100,000 majority of the white votes which could be reversed only by unbelievable Democratic corruption.
- <sup>114</sup>*Eufaula Times and News*, December 21, 1893, quoted in Rogers, *One-Gallused Rebellion*, p. 248.
- <sup>115</sup>*Troy Jeffersonian*, March 2, 1892. But the *Jeffersonian*, May 4, 1894, accused the Democrats of threatening to ambush Negroes who voted for Kolb and issued a plea for all men to uphold the right of a man to vote, whatever his race.
- <sup>116</sup>*Dadeville Herald*, quoted in *Birmingham News*, August 4, 1894.
- <sup>117</sup>*Montgomery Advertiser*, May 19, June 7, 1894. In Clay County, the "Kolbites" organized groups of Negro voters to be used to offset Democratic votes. See: Henry Pelham Martin, "A History of Politics in Clay County during the Period of Populism from 1888-1896" (M.A. thesis, University of Alabama, 1936), pp. 68-69.
- <sup>118</sup>Rogers, *One-Gallused Rebellion*, p. 281.
- <sup>119</sup>*Montgomery Advertiser*, June 16, 1894.



<sup>120</sup>*Ibid.*, June 7, 1894.

<sup>121</sup>*Ibid.*, June 24, 1894.

<sup>122</sup>*Ibid.*, May 19, 1894.

<sup>123</sup>Birmingham *Age-Herald*, August 2, 1894.

<sup>124</sup>Charles B. Spahr, *American's Working People* (New York, 1909), p. 103, quoted in C. Vann Woodward, *Origins of the New South, 1877-1913* (Baton Rouge, La.: Louisiana State University Press, 1951), p. 257; Saunders, "Southern Populists and the Negro," pp. 255-256.

<sup>125</sup>Saunders, "Southern Populists and the Negro," pp. 255-256. Also see: Leah R. Atkins, "Populism In Alabama: Reuben F. Kolb and the Appeals to Minority Groups," *Alabama Historical Quarterly*, XXXII (1970), pp. 167-180.

<sup>126</sup>Saunders, "Southern Populists and the Negro," p. 256.

<sup>127</sup>Birmingham *Age-Herald*, August 3, 1894.

<sup>128</sup>Selma *Times*, cited in Montgomery *Advertiser*, July 22, 1894.

<sup>129</sup>Saunders, "Southern Populists and the Negro," p. 256. Oates's sincerity in appealing to blacks is highly suspect in view of his statements made on two different occasions. In an interview given while in Congress, Oates revealed that he feared Negro rule would result if blacks voted and their votes were counted. See: Allen J. Going, *Bourbon Democracy In Alabama, 1874-1890* (University, Ala., 1951), p. 39. Addressing the 1894 graduating class of Tuskegee Institute, after the preceding speaker had hinted that a new era in racial relations was forthcoming, Oates said:

I want to give you niggers a few words of plain talk and advice. No such address as you have just listened to is going to do you any good; it's going to spoil you. You had better not listen to such speeches. You might as well understand that this is a white man's country as far as the South is concerned, and we are going to make you *keep your place*. Understand that. I have nothing more to say.

See: Naomi Friedman Goldstein, *The Roots of Prejudice Against the Negro in the United States* (Boston: Boston University Press, 1948), p. 60n.

<sup>130</sup>Birmingham *News*, July 20, 1894.

<sup>131</sup>Birmingham *Age-Herald*, August 3, 1894.

<sup>132</sup>Montgomery *Advertiser*, July 25, 1894.

<sup>133</sup>Sparkman, "Kolb-Oates Campaign," p. 28. In August, Bowman was placed under a peace bond for threatening A. J. O'Keefe, the editor of the Birmingham *Independent*. See: Birmingham *Age-Herald*, August 4, 1894.

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- 134 *Montgomery Advertiser*, July 24, 1894.
- 135 Cole, "Populism in Tuscaloosa County," p. 74.
- 136 *Ibid.*, pp. 76, 82.
- 137 *Montgomery Advertiser*, April 12, June 26, July 28, August 4, 1894; *Troy Jeffersonian*, June 8, 1894.
- 138 *Montgomery Advertiser*, June 30, July 12, 1894; Albert Burton Moore, *A History of Alabama and Her People* (Chicago, 1927), I, p. 728.
- 139 Sparkman, "Kolb-Oates Campaign," p. 38.
- 140 *Manuscript Election Returns, Alabama Gubernatorial Election, 1894*, Files of the Secretary of State, Alabama Department of Archives and History, Montgomery.
- 141 Hearn, "Populist Movement in Marshall County," p. 92.
- 142 *Birmingham Age-Herald*, August 8, 1894; *Troy Jeffersonian*, August 10, 1894.
- 143 *Birmingham Age-Herald*, August 8, 1894.
- 144 *Troy Jeffersonian*, August 17, 1894; *Birmingham Age-Herald*, August 10, 1894.
- 145 *Troy Jeffersonian*, August 10, 1894.
- 146 *Birmingham Age-Herald*, August 8, 1894. Professor Malcolm Cook McMillan has concluded, in *Constitutional Development in Alabama*, p. 224, that the Sayre law disfranchised many poor whites and Negroes and served to keep the Democratic party in power. Also see: David Ashley Bagwell, "The 'Magical Process': The Sayre Election Law of 1893," *Alabama Review*, XXV (April, 1972), pp. 83-104.
- 147 *Troy Jeffersonian*, August 17, 1893; *Birmingham Age-Herald*, August 10, 1894.
- 148 Horace Wood to McKee, June 13, 1894, McKee Papers; *Birmingham Age-Herald*, August 24, 1894.
- 149 Kolb to Chandler, August 20, September 22, 1894, William E. Chandler Papers, Library of Congress, quoted in DeSantis, *Republicans Face the Southern Question*, p. 249.
- 150 William Allen, Populist Senator from Nebraska, after reading into the *Congressional Record* a number of petitions from Alabamians calling for honest elections, offered a resolution to that effect that was defeated in the third session of the Fifty-Third Congress. Chandler tried to resurrect his resolution in the second session of the Fifty-Fourth Congress, but was ruled out-of-order. See: U.S., Congress, Senate, 53rd Cong., 3rd. sess., *Congressional Record*, XXVII, p. 428; and U.S.

Congress, Senate, 54th. Cong., 2nd. sess., *Congressional Record*, XXIX, p. 231.

<sup>151</sup>Clark, *Populism in Alabama*, pp. 155, 158; *Montgomery Advertiser*, November 13, 1894.

<sup>152</sup>*Northport West Alabama Breeze*, November 22, 1894.

<sup>153</sup>Clark, *Populism in Alabama*, pp. 158-159.

<sup>154</sup>*Birmingham Age-Herald*, June 28, 1914, quoted in McMillan, "Alabama Constitution of 1901," p. 50.

<sup>155</sup>Summersell, "Reuben F. Kolb," p. 118.

ELECTRICITY USE IN ALABAMA BY INCOME CLASS WITH  
IMPLICATIONS REGARDING THE EFFECTIVENESS OF  
LIFELINE RATE STRUCTURES<sup>1</sup>

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INTRODUCTION

This paper presents the results of a study to determine how much electricity is used, on the average, by consumers at different income levels. This information is then analyzed to show the effect of changing the electricity rate structure to some "lifeline" form (low rates for initial use with rates increasing as use increases). Although utility companies are aware of the average consumption for all customers, they generally have not had data that break down the averages by income classes. Earlier research by the authors has shown empirically that consumer income is an important factor in electricity consumption (1, 2, 3).

The importance of information based on income categories has increased as regulatory agencies have sought ways to relieve the burden of rising electric bills on the poor through some form of rate change. All of the proposed programs have given rise to serious questions regarding efficacy and efficiency as well as the obvious consideration of equity in rate decisions. Without a better knowledge of electricity consumption and user behavior by income class, many of these plans cannot be properly evaluated by either the utilities or the regulatory agencies. This study fills some of the gaps in such knowledge and provides an aid to sound decision making.

The set of income classes chosen for analysis is given in Table 1, with the number of observations in each class. The final sample size was 1,446 customers, each of whom had to be placed into one of the income classes shown.

SELECTION OF SAMPLE AND INCOME IDENTIFICATION

To allow the income segmentation necessary for this study, census tracts were chosen that (a) represented a broad cross section of income averages from three cities; Birmingham, Mobile, and Montgomery, and (b) had a reasonably high concentration of incomes within a range around the

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TABLE 1

## INCOME CLASSES USED IN THE STUDY

Income Class	Number of Observations	Income Range
I	34	0- \$2,999
II	70	\$3,000- \$4,999
III	165	\$5,000- \$7,499
IV	305	\$7,500- \$9,999
V	453	\$10,000-\$14,999
VI	181	\$15,000-\$19,999
VII	58	\$20,000-\$24,999
VIII	150	\$25,000 and over

mean and median. Obtaining the broad cross section was no problem. However, since most census tracts have a wide range of incomes within their territory, the second requirement was more difficult to fulfill. The middle income categories presented difficulties in location of high concentrations around the mean and median. The very high and very low incomes were more concentrated.

A request was made to Alabama Power Company to provide a listing of customers that would be sufficient in number to give a fairly large sample in each income category after numerous criteria were placed on each customer for selection. The original selection, a systematic random sample, included approximately 24,000 consumers. To assure their placement in the proper tracts, every customer selected and their alternates were located on maps taken from the U.S. Census of Birmingham, Mobile, and Montgomery. Customers located outside the desired tracts were eliminated from the sample. This stage of the study reduced the total sample by about one-half to approximately 12,000.

As a first step toward placing the customers into an income class, the occupations of the 12,000 remaining customers were sought in the city registers of Birmingham, Mobile, and Montgomery. Only about one-half of the customers were listed, reducing the sample to about 6,000. Customers who had experienced a change in address were dropped from the sample since we desired to compare consumption levels for two different time periods. Retired persons, widows, students and most self-employed persons, except professionals were also dropped from the sample because income identification was extremely hazardous. A separate study of widows and retired persons is being conducted along these same lines. This step left the sample size in the neighborhood of 5,000.

The most difficult task of the study was the assignment of customers into income classes. The following factors were evaluated in classifying each customer into an income group:

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1. Location by census tract
2. Mean and median incomes for each tract
3. Race of customer
4. Distribution of incomes within each census tract
5. Occupation by customer
6. Mean and median incomes of occupations
7. Distribution of incomes by occupation
8. Approximate housing value of customer

Unless each of the considerations was reasonably consistent with the others, the customer was eliminated from the sample.

Certain biases from the tract distributions were bound to occur as a result of the use of the city register. For example, only a small percent of the very low income class was listed in the registers. This result was expected to and did, give an upward bias to the low income classes. Extremely high incomes tend to be biased downward because of the reporting of income averages used.

Another factor used to aid in income classification was the distribution of income within occupational classes. In some cases the incomes are closely concentrated, allowing relative ease of income assignment. Even when widely dispersed, this information was valuable when considering all of the factors collectively. In some cases, certain income classes could be eliminated from consideration.

The race of the customer was also taken into consideration. The degree of black and white concentration within tracts was very high. Where doubt existed as to the race, an examination of the census block within the tract generally provided the answer with extremely high probability, often 100 percent. Each of the census tables for income was given for blacks separately. Since a considerable difference in income by occupational titles was noted between blacks and whites, the black or white breakdown was essential to the procedure and proved extremely valuable for cutting down the distributional range of incomes for each occupation.

The apparent achievement level within an occupation was also considered. Although the census does not break down occupations by levels, the attachment of words such as "chief," "head," "leader," "main" or other descriptive terms were used to place the customer within the distribution of income.

Another factor used to aid in the income classification was the approximate value of the home occupied by the owner. This information is available by census block. A ratio of household value to income for each tract was computed simply as a rough guide, realizing that there would be wide divergence from this ratio. However, this information provided an additional factor for income consideration. Since the likelihood of a person earning ten thousand dollars per year and living in an area of fifty or sixty thousand dollar homes is small, comparisons of this type proved useful for income classification and/or elimination from the sample. The final sample included 1,446 customers.

## RESULTS

This study entailed data on kilowatt-hour use of electricity for 1,446 Alabama Power Company customers for 1971 and 1975. Table 2 presents the average kwh consumption and standard deviations by income class for the two years. Average use increases in every income class for both years as does the standard deviation, indicating less concentration as income rises. An examination of the differences in consumption levels between 1971 and 1975 reveals an interesting pattern. The lower income classes, I through IV, exhibit an increase in use with the percentage change between the years following a decreasing pattern except from class I to class II. Consumption in class V remains approximately constant (+7 kwh on a base of 13,527 kwh) and declines for the higher income groups, with the percentage decline increasing as incomes increase. This shifting use pattern may be attributable to a number of factors. One possibility is that growing appliance saturation for upwardly mobile low-income customers keeps their use rising while high-income customers with very high saturations of appliances try to conserve energy. The largest percentage decreases experienced were in classes VII and VIII, the over \$20,000 income groups, and constitute only a small proportion of the total population in Alabama.

Weather does not appear to have been a major factor in any differential between the two years. Two of the basic measures of the need for heating and air conditioning are called heating degree days and cooling degree days respectively. Heating (Cooling) degree days measures the amount of time the temperature is recorded below (above) 65 degrees, times the number of degrees below (above) 65 degrees. From 1971 to 1975 a 6.4 percent decrease in heating degree days and a 6 percent increase in cooling degree days was noted (5). Weather would favor a slight increase in consumption for 1975, depending on the distribution of cooling and heating degree days.

Table 3 gives the relative frequency (the percent of the observations in the class) distribution for all eight income classes for 1971. Table 4 gives the same information for 1975. In both tables the increased use with higher levels of income can be traced by examining the modal values. The increase in use from class I with 31.4 percent of the observations in the less than 2,000 kwh group, to class VII, with 19.0 percent of the observations between 14,000 and 15,999 kwh is fairly steady. Then there is a sharp increase for class VIII with 19.7 percent of the observations with over 30,000 kwh for the year. This last figure is probably attributable to a larger percentage of all-electric homes in this income class and to the open ended interval itself covering all incomes over \$25,000. The pattern of the modal values for the 1975 consumption is much the same as 1971 although not quite as smooth.

The concentration of kwh's around the modal class decreases as the income level increases in both years. For class I, the lowest income group, 62.8 percent of the customers in 1971 (60 percent in 1975) used less than 4,000 kwh; for income class II, 51.4 percent of the customers used 2,000 to 6,000 kwh. When class IV is examined, a spread of 6,000 kwh (6,000 to 12,000) is needed to account for 60 percent of the customers in 1971 (8,000 kwh spread in 1975). The concentration of use



TABLE 2  
AVERAGE YEARLY KWH CONSUMPTION BY INCOME  
CLASS FOR 1971 AND 1975

Income Class	1971		1975		Percent Change (Mean)
	Mean	Standard Deviation	Mean	Standard Deviation	
I	3,868	2,877	4,501	2,969	+16.4
II	5,778	4,134	6,985	4,580	+20.6
III	7,206	4,469	8,159	4,461	+13.2
IV	11,166	4,826	11,756	4,928	+ 5.3
V	13,527	5,533	13,535	5,349	0
VI	15,695	5,927	15,603	5,743	- 0.6
VII	18,739	7,878	17,919	8,047	- 4.4
VIII	23,025	11,460	21,755	9,777	- 5.5

TABLE 3  
RELATIVE FREQUENCY DISTRIBUTIONS OF ELECTRICITY USE BY INCOME CLASS, 1971  
(ALL FIGURES IN PERCENTAGES)

Annual kwh Used	Income Class							
	I	II	III	IV	V	VI	VII	VIII
0- 1,999	31.4	13.2	5.4	0.9	0.4	0	0	0.7*
2,000- 3,999	<u>31.4</u>	27.9	19.8	3.4	1.7	0.6*	1.7*	0
4,000- 5,999	<u>14.3</u>	<u>23.5</u>	<u>23.4</u>	6.9	2.2	3.4	0	0.7*
6,000- 7,999	17.1	14.7	<u>17.4</u>	15.0	10.2	3.4	3.4	2.0
8,000- 9,999	2.9*	4.4	12.6	19.7	13.8	8.9	3.4	2.7
10,000-11,999	0	4.4	7.8	<u>16.6</u>	16.4	6.7	1.7*	3.4
12,000-13,999	2.9*	2.9	4.2	13.4	<u>12.7</u>	17.3	15.5	4.1
14,000-15,999	0	5.9	4.8	10.4	14.3	<u>15.1</u>	<u>19.0</u>	10.9
16,000-17,999	0	2.9	2.4	4.7	9.3	16.2	<u>12.1</u>	12.9
18,000-19,999	0	0	0	2.8	7.6	10.6	6.9	9.5
20,000-21,999	0	0	1.2	2.8	3.9	4.5	13.8	9.5
22,000-23,999	0	0	1.2	1.6	3.7	4.5	6.9	9.5
24,000-25,999	0	0	0	0.3*	0.4	3.4	5.2	7.5
26,000-27,999	0	0	0	0.3*	1.3	2.2	3.4	4.8
28,000-29,999	0	0	0	0.3*	0.9	0.6*	0	2.0
30,000 and over	0	0	0	0.3*	1.3	2.8	6.9	<u>19.7</u>

Note: \* Indicates only one observation

TABLE 4  
RELATIVE FREQUENCY DISTRIBUTIONS OF ELECTRICITY USE BY INCOME CLASS, 1975  
(ALL FIGURES IN PERCENTAGES)

Annual kwh Used	Income Class							
	I	II	III	IV	V	VI	VII	VIII
0- 1,999	17.1	10.3	2.4	1.6	0.6	0	0	0
2,000- 3,999	42.9	20.6	16.2	4.1	1.1	0	1.7*	0
4,000- 5,999	14.3	17.6	17.4	3.6	2.4	3.4	1.7*	0
6,000- 7,999	11.4	16.2	19.2	10.0	8.0	5.0	1.7*	2.7
8,000- 9,999	8.6	13.2	19.2	19.7	14.5	6.7	6.9	2.7
10,000-11,999	0	5.9	11.4	18.1	16.3	12.3	6.9	6.1
12,000-13,999	2.9*	5.9	4.2	15.9	15.1	11.7	13.8	7.5
14,000-15,999	2.9*	4.4	4.2	7.2	12.1	18.4	19.0	10.9
16,000-17,999	0	2.9	0.5*	7.8	11.4	11.7	5.2	14.3
18,000-19,999	0	2.9	3.0	6.3	6.5	12.3	12.1	8.2
20,000-21,999	0	0	1.2	3.2	5.4	5.0	10.3	7.5
22,000-23,999	0	0	0.5*	1.3	2.6	6.7	3.4	8.8
24,000-25,999	0	0	0	0.3*	1.7	2.8	5.2	4.8
26,000-27,999	0	0	0.5*	0.6	0.6	1.1	5.2	2.7
28,000-29,999	0	0	0	0.3*	0.9	0.6*	1.7*	4.1
30,000 and over	0	0	0	0	0.9	2.8	5.2	19.7

Note: \* Indicates only one observation

around the modal level decreases as income increases from class I through class VIII. This relationship holds within the 1975 data also. However, a comparison between the 1971 and 1975 Tables 3 and 4, and an examination of the standard deviations of Table 2 shows that there was less variability within income classes in 1975 than there was in 1971. The fact that emerges most clearly from these data is that while there is considerable variation in electricity use within income classes, the relationship between income and use is very strong. The variability in use increases as income increases. Some of the most likely causal factors of this variability are the choice of other forms of energy such as natural gas or heating oil, different insulation factors in homes, the amount of time spent in homes by members of the family, different attitudes toward conservation, and the tastes and preferences of the consumers regarding appliances. The higher the income level, the more options are available for electricity use.

#### IMPLICATIONS FOR DECISION MAKING

The type of information provided by this study can be useful to decision makers involved with rate making for utilities. An area of concern is that utilities may be required to adopt so-called "lifeline" rates or inverted rate structures. Such rate structures involve a low charge per kwh for the first block of kwh's consumed, and higher charges beyond that block--in effect, an increasing price structure for increased usage. The lifeline rate could be modified to have several blocks of increased rates above the minimum segment. The purpose of "lifeline" rates is to provide a lower priced service to the poor. However, since electric utilities themselves cannot provide welfare services and must earn a return, the rates for high and possibly medium level users would have to be increased to compensate for revenue losses. Such rates also place an increased burden on persons who heat with electricity as opposed to natural gas or some other energy form.

One question regarding the lifeline rate that can be partially answered with the data of this study is: What percent of the poor will actually be helped by any given price structure, and how different income level customers will be affected. For example, assume that the four rates in Table 5 are being considered as an alternative to a flat rate of three cents per kwh. This rate is slightly above current winter month rates and slightly below current summer month rates for Alabama Power Company. The bills for each of these rates of various levels of kwh consumption are shown in Table 6.

Rate A, a very modest price lifeline, reaches a breakeven cost when compared with the flat 3 cent rate at 600 kwh of consumption, with a maximum saving of three dollars to customers who use 300 kwh. Above that quantity, the saving falls.

Rate B reaches a breakeven with the 3 cent rate at 1400 kwh, with a maximum saving of \$4. Rate C reaches the breakeven point at 1200 kwh with a maximum saving of \$8. The most liberal of the prices, rate D, reaches breakeven at 1600 kwh and a maximum saving of \$8.

By converting the 1975 figures from Tables 2 and 3 to monthly averages and assuming that the percentages are evenly distributed over each

TABLE 5  
PROPOSED RATES

Rate	Description of Structure
A	Modest Two-Price Structure: Two cents/kwh for 1st 300 units Four cents/kwh for all above 300 units
B	Intermediate Three-Price Structure: Two cents/kwh for 1st 400 units Three cents/kwh for next 600 units Four cents/kwh for all above 1000 units
C	Extreme Two-Price Structure: One cent/kwh for 1st 400 units Four cents/kwh for all above 400 units
D	Extreme Three-Price Structure: One cent/kwh for 1st 400 units Three cents/kwh for next 400 units Four cents/kwh for all above 800 units

TABLE 6  
BILLS FOR VARYING RATE STRUCTURES WITH DIFFERENCES IN PAYMENT  
FROM A FLAT THREE CENT RATE BY KWH USE LEVELS

(1) Consumption in kwh	(2) Bill at Rate A	(3) Bill at Rate B	(4) Bill at Rate C	(5) Bill at Rate D	(6) Bill with Flat 3¢ Rate	(7) Rate A Difference (2)-(6)	(8) Rate B Difference (3)-(6)	(9) Rate C Difference (4)-(6)	(10) Rate D Difference (5)-(6)
300	6.00	6.00	3.00	3.00	9.00	-3	-3	-6	-6
400	10.00	8.00	4.00	4.00	12.00	-2	-4	-8	-8
600	18.00	14.00	12.00	10.00	18.00	0	-4	-6	-8
800	26.00	20.00	20.00	16.00	24.00	+2	-4	-4	-8
1000	34.00	26.00	28.00	24.00	30.00	+4	-4	-2	-6
1200	42.00	34.00	36.00	32.00	36.00	+6	-2	0	-4
1400	50.00	42.00	44.00	40.00	42.00	+8	0	+2	-2
1500	54.00	46.00	48.00	44.00	45.00	+9	+1	+3	-1
1600	58.00	50.00	52.00	48.00	48.00	+10	+2	+4	0
2000	74.00	66.00	68.00	64.00	60.00	+14	+6	+8	+4
2500	94.00	86.00	88.00	84.00	75.00	+19	+11	+13	+9
3000	114.00	106.00	108.00	104.00	90.00	+24	+16	+18	+14
4000	154.00	146.00	148.00	144.00	120.00	+34	+26	+28	+24

## Electricity Use in Alabama

use level in Table 3, Table 7 can be constructed showing what percentages of each income class will benefit or lose by each proposed rate. Table 3 is used instead of Table 4 so that 1970 usages will be comparable to 1970 income level.

For Rate A, 87.36 percent of the customers in income class I and 73.42 percent of the customers in income class II would receive lower bills on the average. However, even in these low income classes, under \$5,000, 12.64 percent of the customers in income class I and 26.58 percent of the customers in income class II would suffer higher bills. Also a small percentage of the persons in the upper income classes would be benefiting from the change.

Without elaborating on the details of Table 7, one result becomes evident. For a company to attempt to aid the poor with only an inverted rate structure, without also harming a significant proportion of them in return, they must adopt a rate structure that will also give significant levels of benefit to middle income and, to a lesser but still large percentage, upper income groups. This result would take place with Rates B, C, and D. It is questionable, however, whether these rate structures would prove financially sound for utilities. Further analysis of use levels and price response evaluations are necessary.

The rate structures used for analysis in this study, although hypothetical, are not unreasonable. They point up the problem of attempting to aid the poor through rate relief. The type of proposal treated here is only one of a myriad of different proposals that have been set forth, but the additional information of the type provided by this study has some use in many of them.

The information provided in this study indicates that "lifeline" rates are not a good method of aiding the poor, if they are based on usage levels. This supports our earlier findings (3) and raises again the question of whether utilities should be involved in the welfare business at all. The authors' contention is that welfare is the role of government and not private enterprise. Among the programs that might better suit the needs of the poor are cash payments to compensate for rising electricity prices and a federal and/or state program aimed at increasing resources to insulate low income housing.

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TABLE 7  
PERCENT BENEFITING AND LOSING BY INCOME  
CLASS FOR ADOPTION OF SELECTED RATES

Rate	Effect	Income Class							
		I	II	III	IV	V	VI	VII	VIII
A (Breakeven 600 kwh)	Gain	87.36	73.42	59.04	20.20	10.42	6.04	3.74	2.60
	Lose	12.64	26.58	40.96	79.80	89.58	93.96	96.26	97.40
B (Breakeven 1400 kwh)	Gain	100.00	92.26	96.16	88.78	75.32	61.68	49.64	29.76
	Lose	0	7.74	3.84	11.22	24.68	38.32	50.36	70.24
C (Breakeven 1200 kwh)	Gain	100.00	92.38	91.36	78.58	60.16	43.12	29.60	15.88
	Lose	0	7.62	8.64	21.42	39.84	56.88	70.40	84.12
D (Breakeven 1600 kwh)	Gain	100.00	100.00	97.60	93.28	85.46	77.76	61.04	43.20
	Lose	0	0	2.4	6.72	14.54	22.24	38.96	56.80

Notes: All figures in percentages.

Top figure is percent in each income class benefiting from change to the rate noted from a flat 3¢/kwh level. The lower figure is the percent losing.

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## Notes

# THE JOURNAL OF THE ALABAMA ACADEMY OF SCIENCE

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FUNGI OF ALABAMA VII. DEMATIACEOUS HYPHOMYCETES<sup>1</sup>

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*Auburn University, Auburn, AL 36830*

INTRODUCTION

Ten dematiaceous hyphomycetes collected in Alabama are described and illustrated.

TAXONOMIC PART

*Berkleasium concinnum* (Berk.) Hughes, Can. J. Bot. 36: 740, 1958 (Fig. 1).

≡ *Sporidesmium concinnum* Berkeley, Lond. J. Bot. 4: 309, 1845.

Colonies effuse. Sporodochia punctiform, gregarious or scattered, black. Mycelium immersed in the substratum, composed of branched, septate, smooth, pale brown hyphae, 2-3 $\mu$  wide. Stroma prosenchymatous. Conidiophore macronematous, tightly packed, flexuous, cylindrical, septate, mostly simple, pale yellowish brown, smooth, 16-28  $\times$  2-4.5 $\mu$ . Conidiogenous cells monoblastic, integrated, terminal. Conidia solitary, acrogenous, simple, ellipsoidal to clavate, muriformly septate, smooth, yellowish brown, darker above when young, truncate at the base, 58-110  $\times$  25-30 $\mu$ .

On decorticated wood, Chewacla State Park, Lee County, Alabama, August 12, 1977, G. Morgan-Jones and R. C. Sinclair, AUA.

*Codinaea simplex* Hughes and Kendrick, N.Z. Jl. Bot. 6: 362, 1968 (Fig. 2).

Colonies hypophyllous, effuse, gray. Mycelium immersed or semi-immersed, composed of branched, septate, subhyaline to pale brown, 2-3 $\mu$  wide hyphae. Setae absent. Conidiophores macronematous, mononematous, arising singly or in groups of up to three, cylindrical, attenuating distally, with a swollen basal cell of irregular shape, simple, septate, smooth, brown, straight or flexuous, sympodial, bearing several funnel-shaped, subhyaline collarettes, occasionally proliferating percurrently through a terminal collarette, 40-125  $\times$  3-4.5 $\mu$ . Conidiogenous cells phialidic, integrated, terminal or intercalary. Conidia hyaline, curved, continuous, 14-16  $\times$  2-2.5 $\mu$ , bearing a single, filiform, simple, straight or slightly curved appendage, 5-7 $\mu$  long, at each end.

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<sup>1</sup>Manuscript received 4 December 1977; accepted 5 January 1978.

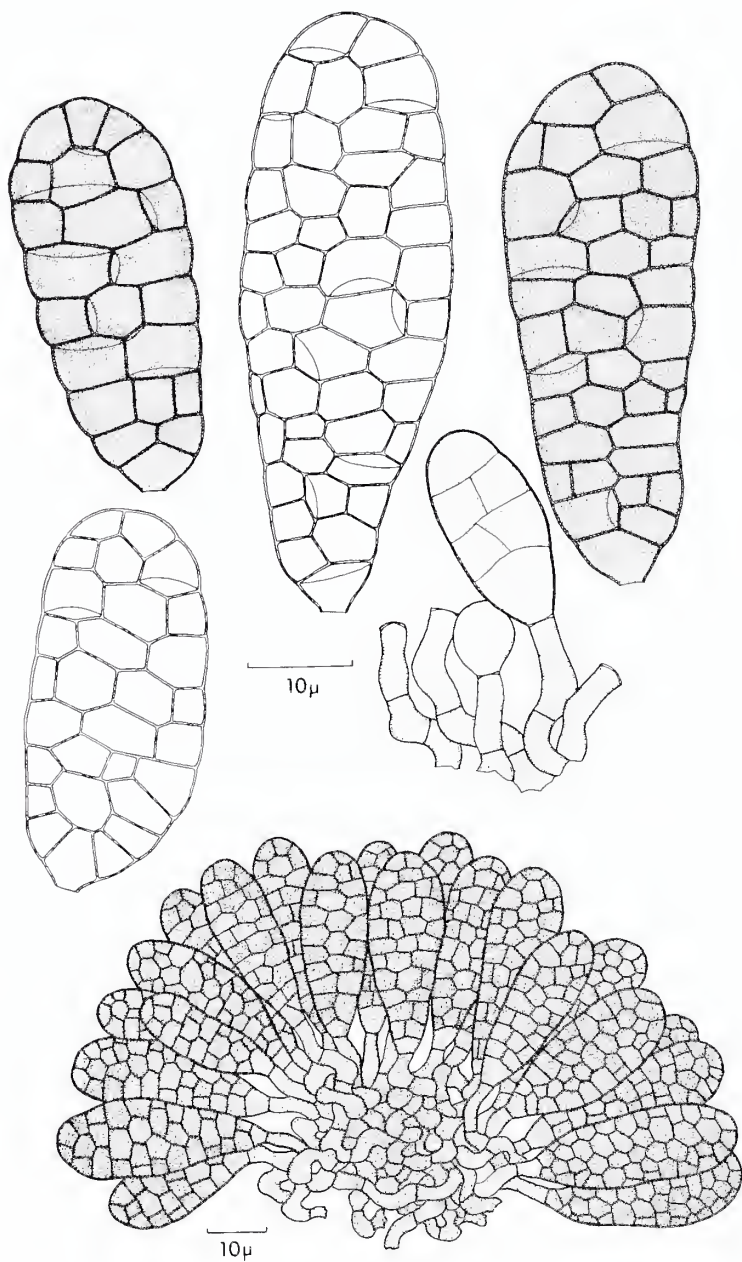


Figure 1. *Berkleasium concinnum*

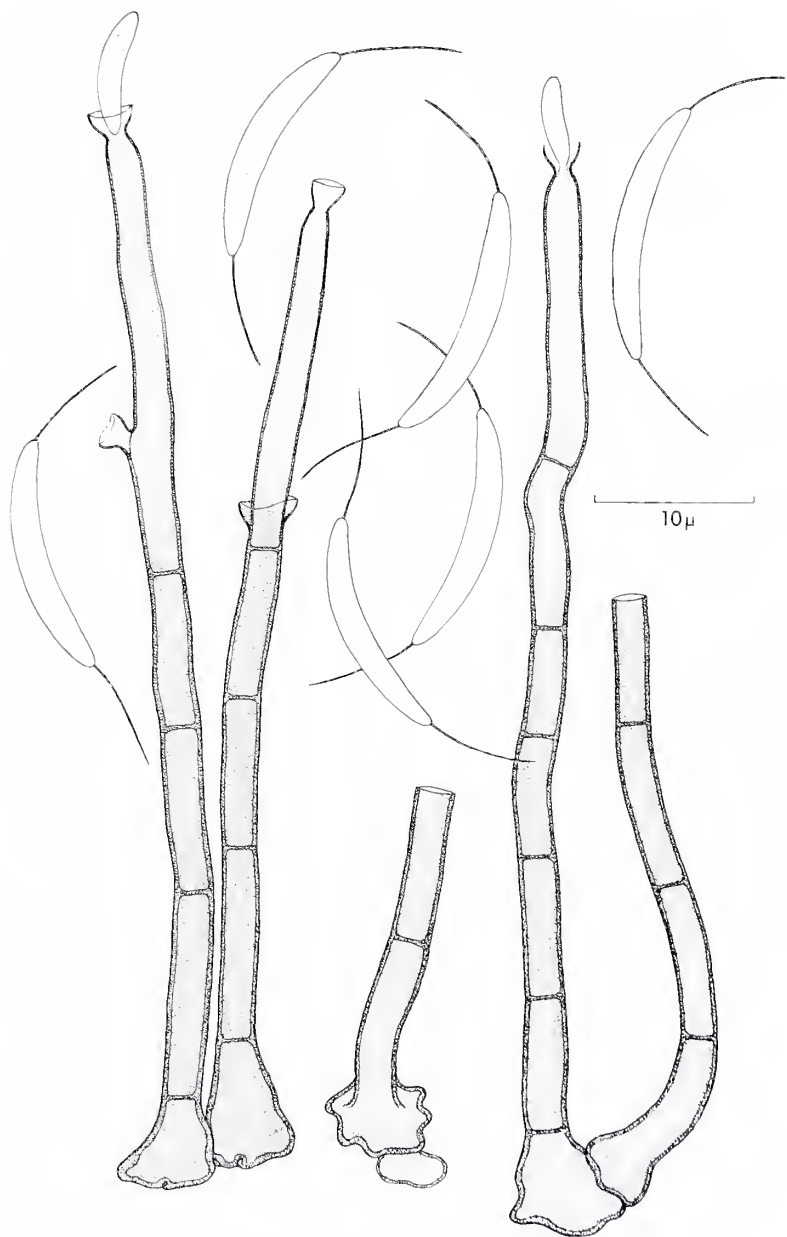


Figure 2. *Codinaea simplex*

On leaves of *Quercus nigra*, Chewacla State Park, Lee County, Alabama, April 1976, E. G. Ingram, AUA.

*C. simplex* was originally described from two collections made on bark of *Weinmannia racemosa* and *Rubus* sp. respectively in New Zealand (Hughes and Kendrick, 1968). It has subsequently been reported from Papua-New Guinea on leaves of *Castanopsis* sp. (Matsushima, 1971), from the Netherlands on acorns of *Quercus robur* (Holubová-Jechová, 1973), and from Japan on leaves of *Podocarpus macrophyllus* and *Quercus* sp. The Alabama collection is the first record of its occurrence in North America.

*Codinaea cylindrospora* Morgan-Jones and Ingram, Mycotaxon 4: 504, 1976 (Fig. 3).

Colonies hypophyllous, effuse, dark brown to almost black. Mycelium immersed, semi-immersed or superficial, composed of branched, septate, subhyaline to pale brown, 1.5-2.5 $\mu$  wide hyphae, aggregated to form small stromata at the bases of setae and conidiophores. Stromatic cells globose or angular, thick-walled, brown, up to 7 $\mu$  wide. Setae arising from dark brown, swollen basal cells, erect, straight, smooth, up to 6-septate, dark brown and thick walled in the lower part, paler above, fertile, terminating in a single, narrowly clavate phialide, 105-125  $\times$  3-4 $\mu$ , 6-7 $\mu$  wide at the bulbous base. Conidiophores macronematous, mononematous, arising in groups of up to four near the base of each seta, cylindrical, with a swollen basal cell, simple, septate, smooth, 30-60  $\times$  2.5-4 $\mu$ , terminating in a single, pale brown to subhyaline, narrowly clavate phialide, each phialide bearing a single apical, funnel-shaped collarette. Conidia hyaline, straight or very slightly curved, continuous, obtuse at each end, 8-11  $\times$  2-2.5 $\mu$ .

On leaves of *Quercus nigra*, Auburn University Forestry Plots, Auburn, Lee County, Alabama, April 1976, E. C. Ingram, BPI, AUA.

*Codinaea unisetula* Morgan-Jones and Ingram, Mycotaxon 4: 507, 1976 (Fig. 4).

Colonies hypophyllous, effuse, gray-brown to black. Mycelium immersed or semi-immersed, composed of branched, septate, subhyaline to pale brown, 1.5-2 $\mu$  wide hyphae. Hyphae giving rise to a few pale brown to brown, subglobose cells, up to 6 $\mu$  wide associated with the conidiophores. Setae absent. Conidiophores macronematous, mononematous, arising singly or in groups of up to three, cylindrical, attenuating slightly distally, with a swollen basal cell, simple, septate, smooth, straight or somewhat flexuous, 28-76  $\times$  2-3 $\mu$ , up to 6 $\mu$  wide at the base, terminating in a single, pale brown to subhyaline phialide or polyphialide bearing funnel-shaped collarettes. Conidia hyaline, straight or very slightly curved, continuous, fusiform, 6-7  $\times$  1, bearing a single, apical, filiform appendage, 13-15 $\mu$  long.

On leaves of *Quercus nigra*, Chewacla State Park, Lee County, Alabama, April 1976, E. G. Ingram, BPI, AUA.

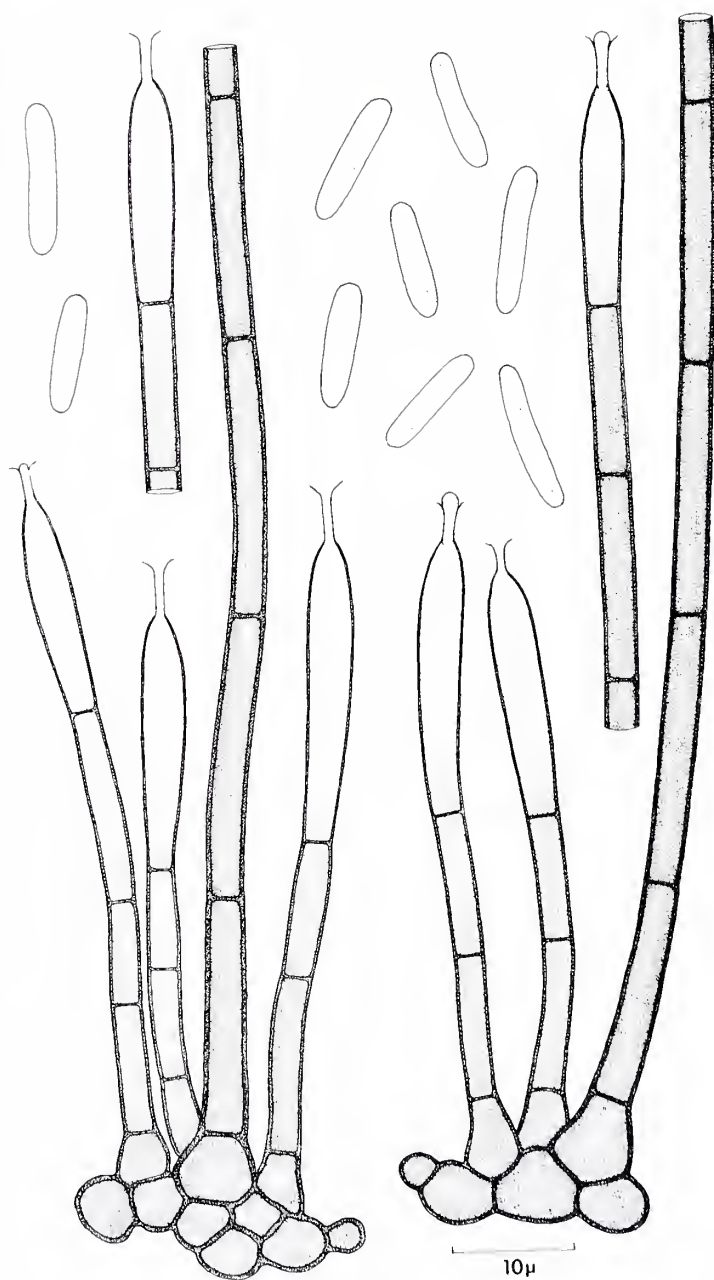


Figure 3. *Codinaea cylindrospora*

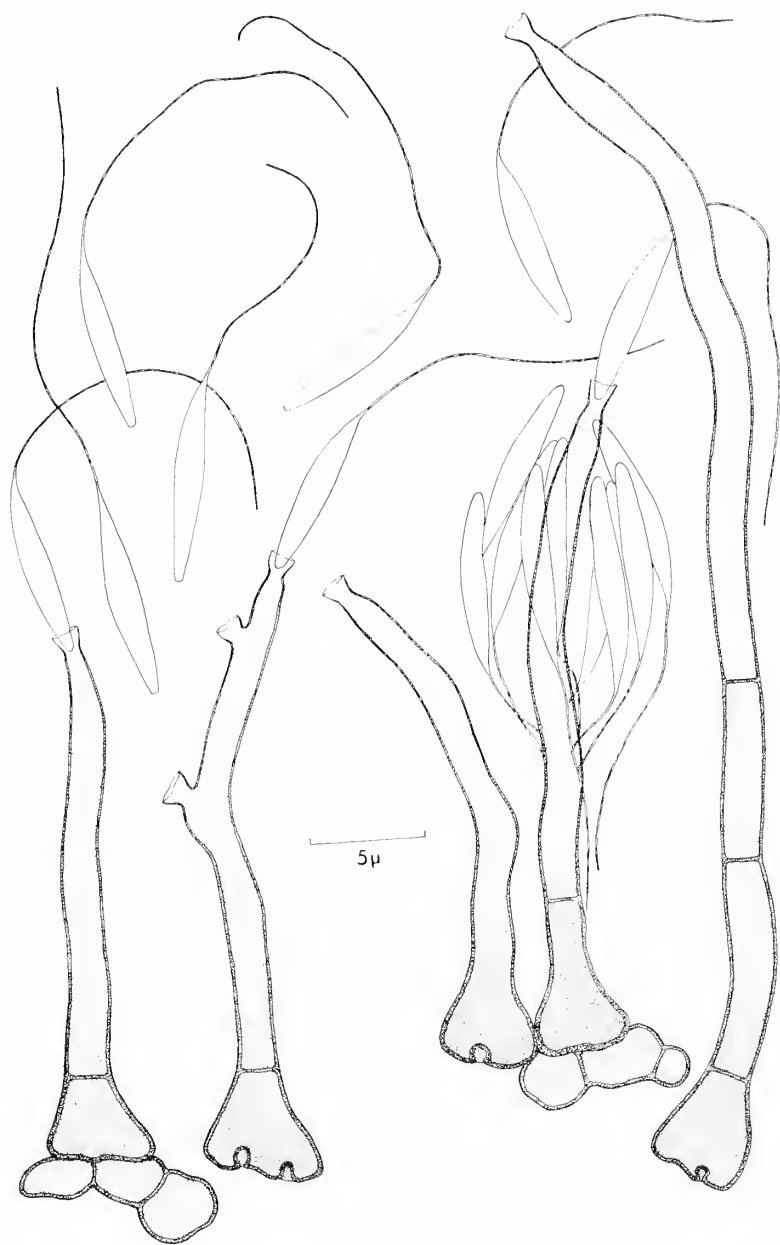


Figure 4. *Codinaea unisetula*



## Fungi of Alabama

*Corynespora foveolata* (Pat.) Hughes, Can. J. Bot. 36: 757, 1958 (Fig. 5).  
= *Helminthosporium foveolatum* Patouillard, Journ. de Bot. 5: 321, 1891.

Colonies effuse, dark brown, hairy. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, pale brown, 3-5 $\mu$  wide hyphae, giving rise to stromatic tissue from which the conidiophores arise. Conidiophores macronematous, mononematous, arising in groups, straight or slightly flexuous, unbranched, cylindrical, brown, septate, smooth-walled, 74-380  $\times$  4-6 $\mu$ , sometimes slightly bulbous at the extreme base. Conidiogenous cells monotretic, integrated, terminal. Conidia solitary, straight or slightly curved, obclavate, frequently rostrate, pale brown, smooth or with the lower four or five cells verruculose, 7 to 8-septate, 67-115  $\times$  7-8 $\mu$ , 1.5-3 $\mu$  wide at the apex.

On culms of *Bambusa* sp., Loachapoka, Lee County, Alabama, April 1976, G. W. Karr Jr., AUA.

This species is mainly tropical in its distribution. We are not aware of a previous record of its occurrence in the United States.

*Helminthosporium velutinum* Link ex Ficin. and Schubert, Fl. Geg. Dresd. Krypt.: 283, 1823 (Fig. 6).

Colonies effuse, black, hairy. Mycelium mostly immersed, composed of branched, septate, pale brown hyphae, 3-4.5 $\mu$  wide. Stroma erumpent, pseudoparenchymatous, dark brown. Conidiophores macronematous, mononematous, frequently caespitose, straight or flexuous, simple, cylindrical, brown, thick-walled, septate, smooth, 350-760  $\times$  9-14 $\mu$ , up to 22 $\mu$  wide at the extreme base. Conidiogenous cells polytretic, integrated, terminal and intercalary, determinate. Conidia solitary, acropleurogenous, straight or slightly curved, obclavate, pale brown, lighter towards the apex, smooth, 8-15-pseudoseptate, 52-89  $\times$  12-16 $\mu$ , tapering to 5-7 $\mu$  wide at the apex, with a dark brown basal scar.

On twigs of *Buxus sempervirens* var. *suffruticosa*, Auburn, Lee County, Alabama, March 1977, C. A. Carr, AUA.

*Periconia cookei* Mason and M. B. Ellis, Mycol. Pap. 56: 72, 1953 (Fig. 7).

Colonies effuse, black, hairy. Mycelium mostly immersed in the substratum, composed of branched, septate, smooth, hyaline to pale brown hyphae, 1.5-3.5 $\mu$  wide. Stroma small, immersed, dark brown, pseudoparenchymatic. Conidiophores macronematous, mononematous, arising in fascicles of up to six from the stromatic cells, erect, straight or slightly flexuous, brown, thick-walled, septate, cylindrical, smooth, 300-720 $\mu$  long, 16-28 $\mu$  wide at the swollen apex, 11-15 $\mu$  wide in the middle part, 13-22 $\mu$  wide at the base. Conidiogenous cells monoblastic or polyblastic, formed on the swollen conidiophore apex, determinate, ovoid or pyriform, hyaline to pale brown and verruculose, 7-11 $\mu$  wide. Conidia acrogenous, simple, spherical, brown, verrucose, 13-16 $\mu$  in diameter.

On leaves of *Sorghum halepense*, Auburn University Forestry Plots, Auburn, Lee County, Alabama, April 1976, G. W. Karr Jr., AUA.

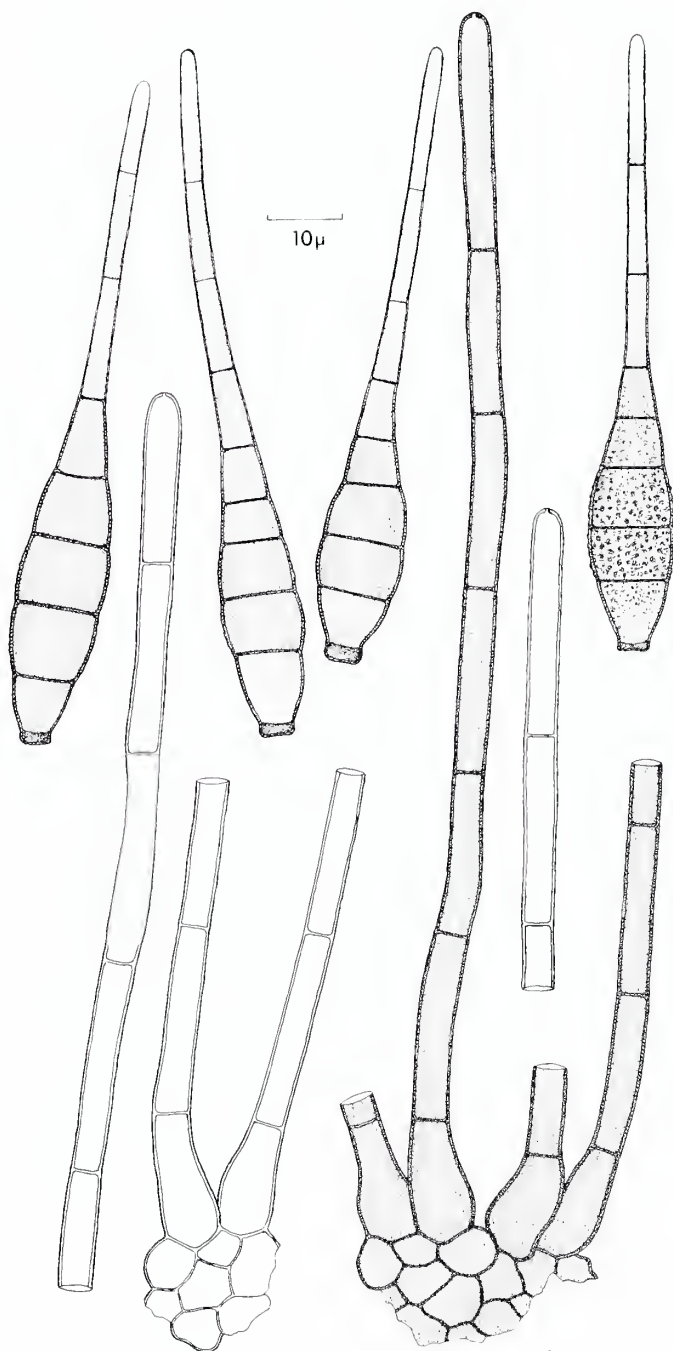


Figure 5. *Corynespora foveolata*

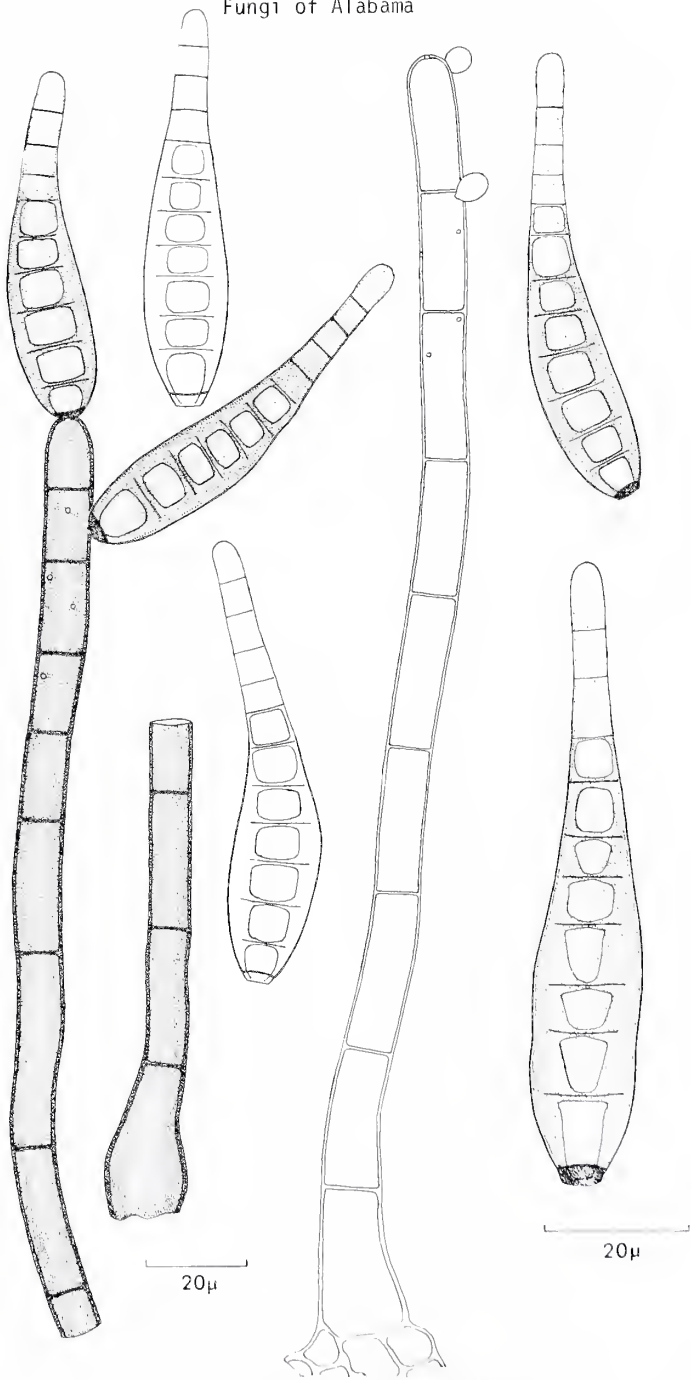


Figure 6. *Helminthosporium velutinum*

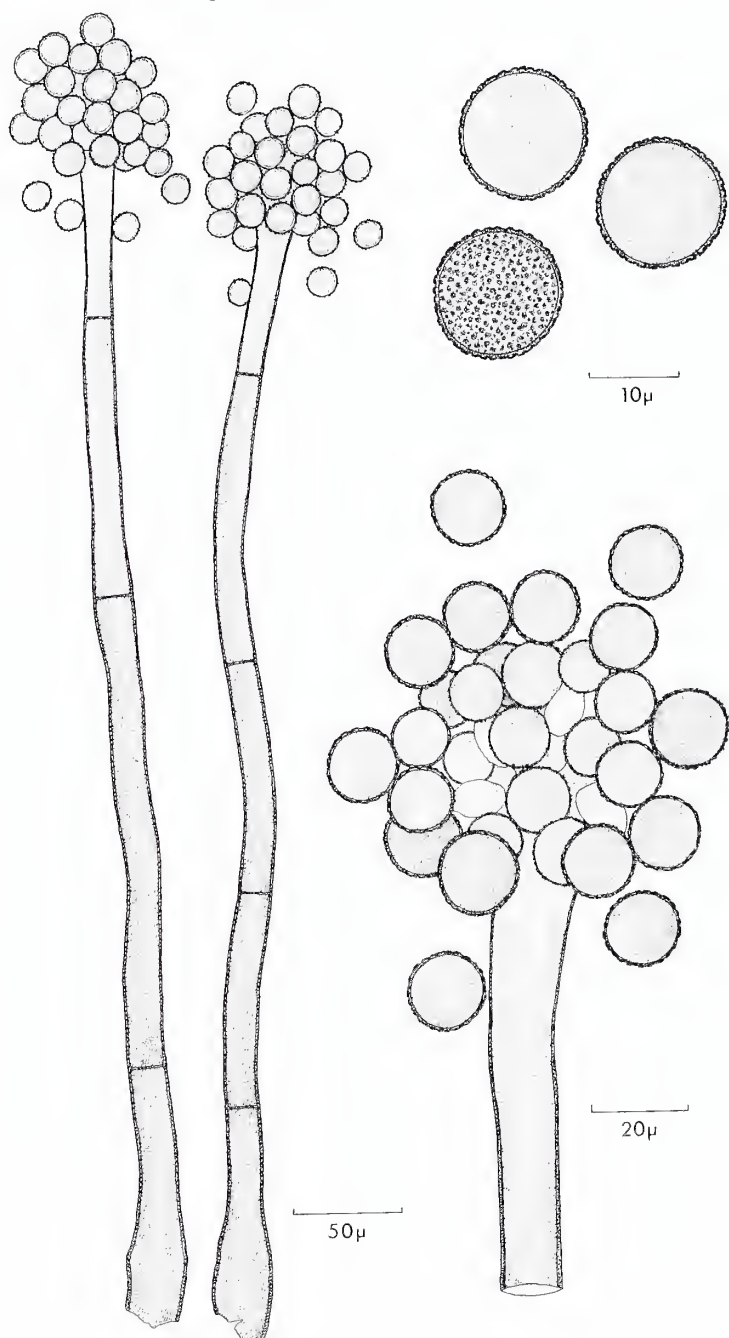


Figure 7. *Periconia cookei*

## Fungi of Alabama

*Pleurothecium recurvatum* (Morgan) Höhnelt, Ber. Deutsch. Bot. Ges. 37: 154, 1919 (Fig. 8).

≡ *Acrothecium recurvatum* Morgan, J. Cincinnati Soc. Nat. Hist. 18: 44, 1895.

Colonies effuse, hairy, dark brown. Mycelium mostly immersed in the substratum, composed of branched, septate, smooth, pale brown hyphae,  $2.5\text{--}4\mu$  wide. Conidiophores macronematous, mononematous, straight or flexuous, simple, smooth, brown, paler above, septate, cylindrical, somewhat bulbous at the base, attenuating at the apex,  $180\text{--}280 \times 4\text{--}7.5\mu$ . Conidiogenous cells integrated, terminal, polyblastic, sympodial, denticulate. Conidia ellipsoid to allantoid, smooth, hyaline, 3-septate, guttulate,  $18\text{--}27 \times 5\text{--}8\mu$ .

On decorticated wood, Chewacla State Park, Lee County, Alabama, August 12, 1977, G. Morgan-Jones and R. C. Sinclair, AUA.

*Spadicoides obovata* (Cooke and Ellis) Hughes, Can. J. Bot. 36: 806, 1958 (Fig. 9).

≡ *Acrothecium obovatum* Cooke and Ellis, Grevillea 5: 50, 1876.

Colonies effuse, black. Mycelium mostly immersed in the substratum, composed of branched, septate, smooth, subhyaline to pale brown hyphae,  $2\text{--}4\mu$  wide. Conidiophores macronematous, mononematous, solitary or in groups of a few, straight or, less frequently, flexuous, simple, smooth, brown, septate, cylindrical, slightly swollen at the base,  $60\text{--}160 \times 4\text{--}9\mu$ . Conidiogenous cells integrated, polytretic, terminal and intercalary, determinate. Conidia solitary, acropleurogenous, obovoid, 2-septate, smooth, brown, with dark bands at the septa,  $12\text{--}15 \times 6\text{--}8\mu$ .

On decorticated wood, Chewacla State Park, Lee County, Alabama, August 1976, G. Morgan-Jones, AUA.

*Stemphylium solani* Weber, Phytopathology 20: 516, 1930 (Fig. 10).

Colonies effuse, dark brown, velvety. Mycelium mostly immersed in the substratum, composed of branched, septate, smooth, subhyaline to pale brown hyphae,  $2.5\text{--}4.5\mu$  wide. A few swollen stromatic cells are present at the base of conidiophores. Conidiophores macronematous, mononematous, solitary or more frequently caespitose, simple, straight or flexuous, nodose, pale brown, smooth,  $120\text{--}180 \times 4\text{--}7\mu$ , vesicular swellings  $8\text{--}10\mu$  in diameter. Conidiogenous cells monoblastic, integrated, terminal, percurrent. Conidia solitary, dry, acrogenous, ellipsoidal, with a pointed conical apex, pale brown, smooth, muriformly septate, constricted at the median transverse septum,  $33\text{--}52 \times 18\text{--}27\mu$ .

On leaves of *Gossypium hirsutum*, nr. Selma, Dallas County, Alabama, J. M. Hammond, July 1977, AUA.

This species has been recorded on both *Lycopersicon* and *Solanum* as the causal organism of small leaf spots. We are not aware of a previous record of its occurrence on cotton.

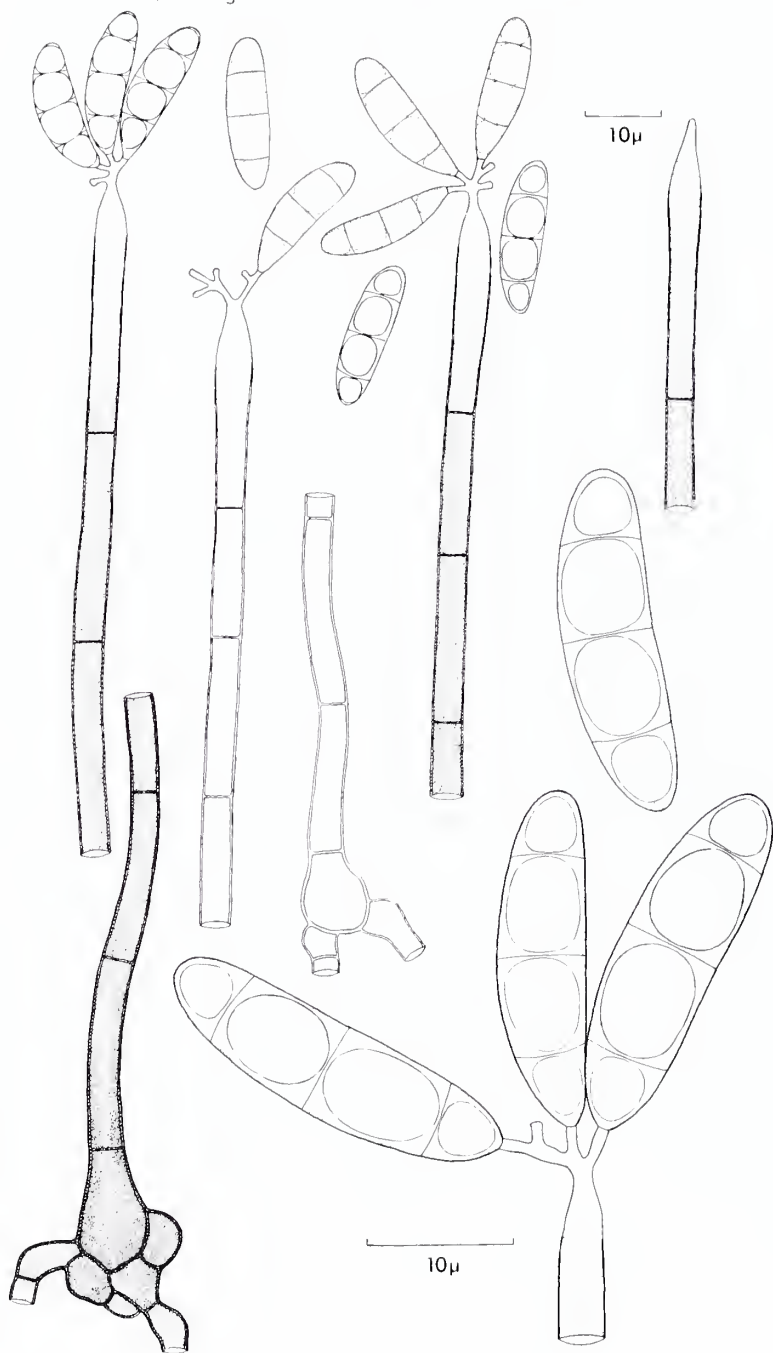


Figure 8. *Pleurothecium recurvatum*

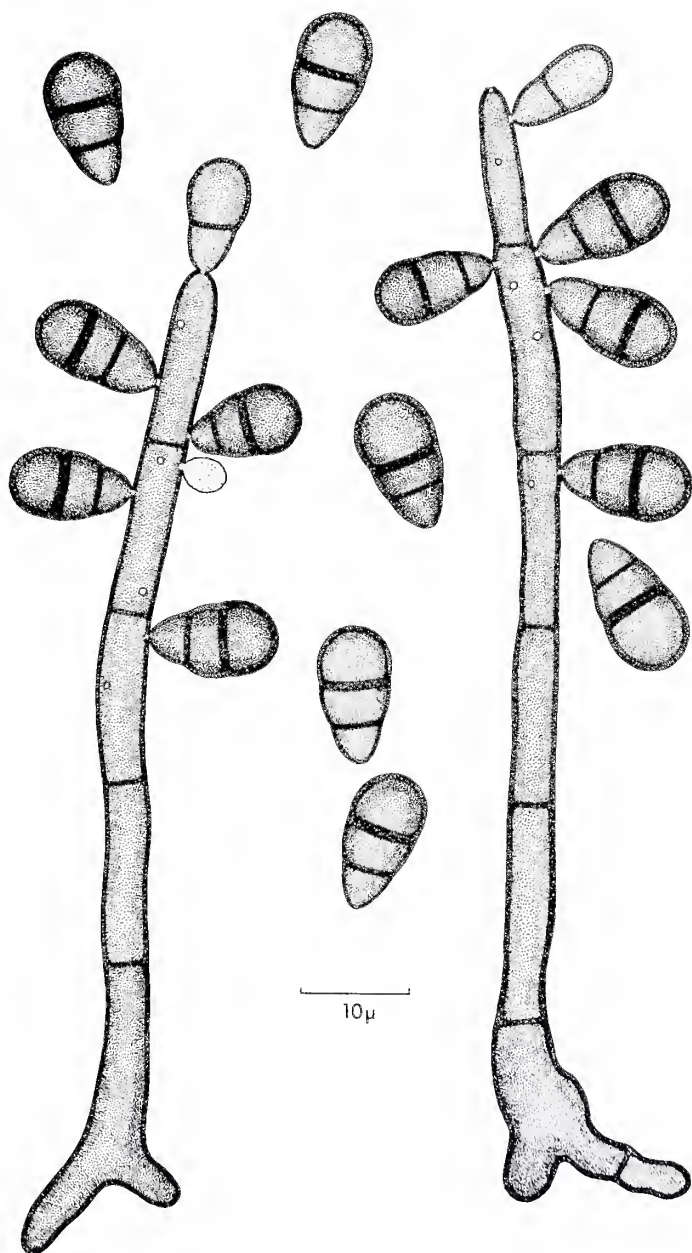


Figure 9. *Spadicoides obovata*



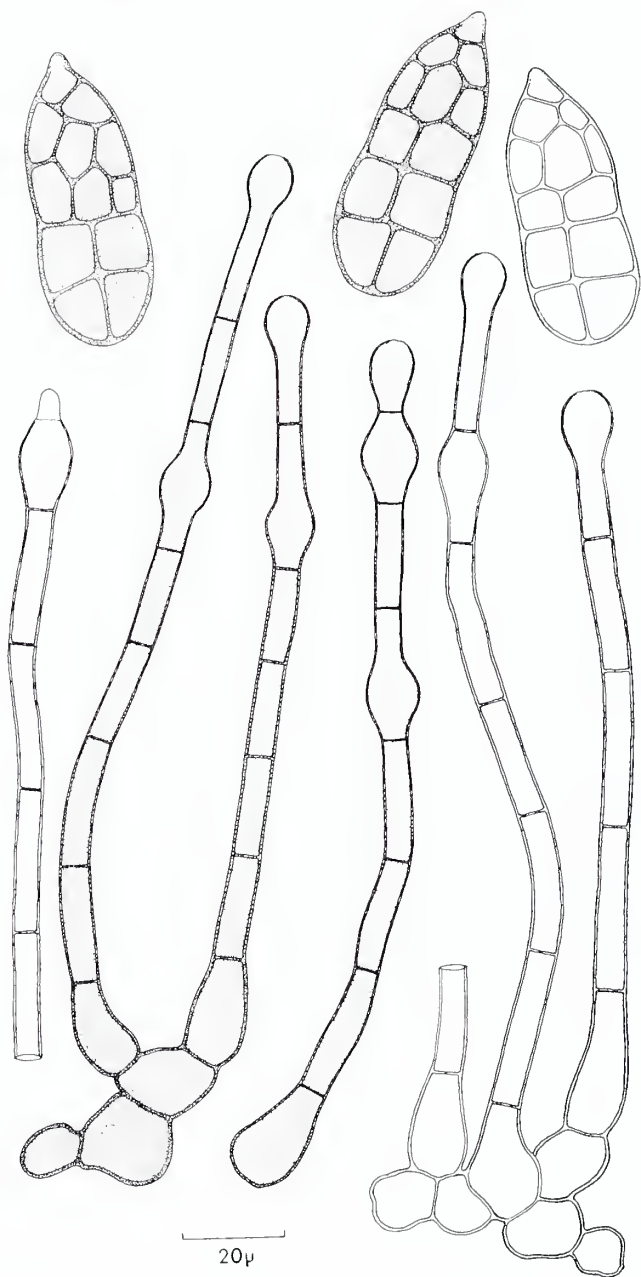


Figure 10. *Stenophylina solani*

## Fungi of Alabama

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- Matsushima, T. 1971. Microfungi of the Solomon Islands and Papua-New Guinea. Kobe. Published by the author.

EFFECT OF pH AND TEMPERATURE ON KINETIC PARAMETERS  
OF PYRIDOXAMINE-PYRUVATE TRANSAMINASE<sup>1</sup>

Jonathan B. Ford

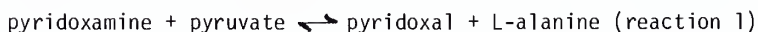
*Chemistry Department, Birmingham-Southern College  
Birmingham, AL 35204*

SUMMARY

The effect of pH and temperature was examined on the kinetic parameters of pyridoxamine-pyruvate transaminase, a vitamin B<sub>6</sub>-requiring enzyme isolated from a soil bacterium. The maximal velocity of reaction for pyridoxamine consumption (forward reaction) and formation (reverse reaction) and the Michaelis constants for all substrates except L-alanine increased with increasing pH in the range pH 7-10. Logarithmic plots of these data showed an ionizing functional group with pK<sub>a</sub> 8.3 in the enzyme-substrate complex and a second group, also with pK<sub>a</sub> 8.3, involved in pyruvate binding in the forward reaction. Redetermination of the pK<sub>a</sub> at several temperatures for the latter group allowed calculation of a heat of ionization of 4200 calories per mole. This functional group was tentatively identified as protein-bound cysteinyl sulphhydryl. These results are discussed in relationship to the pH theory of Dixon and Webb.

INTRODUCTION

In the reversible reaction catalyzed by pyridoxamine-pyruvate transaminase (E.C. 2.6.1.30, reaction 1), pyridoxamine and pyridoxal serve as cosubstrates and no coenzyme is required.



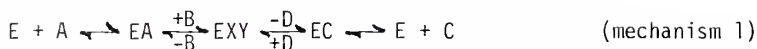
The reaction is similar to the transamination between pyridoxamine and  $\alpha$ -ketoglutarate or oxaloacetate catalyzed by glutamate-oxaloacetate apotransaminase (Wada and Snell, 1962a) but pyridoxamine-pyruvate transaminase is much more effective. Because of the simplicity of this reaction, pyridoxamine-pyruvate transaminase has served as a useful enzyme for studying the mechanism of transamination.

In previous kinetic studies of pyridoxamine-pyruvate transaminase (Ayling and Snell, 1968), the Michaelis constants ( $K_m$ ) and maximal velocities ( $V_{max}$ ) were determined in both directions at 25° and pH 8.85. From these data and related studies, the mechanism of enzyme action was visualized as requiring a symmetrically ordered addition and release of the four substrates of the enzyme:

---

<sup>1</sup>Manuscript received 1 September 1977; accepted 30 September 1977.

## Pyridoxamine-Pyruvate Transaminase



where A, B, C, and D are pyridoxamine, pyruvate, pyridoxal, and L-alanine, respectively. In order to gain further insight into the mechanism of action of pyridoxamine-pyruvate transaminase and to identify chemical groups of the enzyme involved in catalysis or substrate binding, the overall kinetic parameters were studied as a function of pH and the data plotted according to the method proposed by Dixon (Dixon and Webb, 1964). The  $pK_a$  of an ionizing functional group involved in pyruvate binding in the forward reaction, found by the latter method, was examined as a function of temperature to determine its heat of ionization.

### MATERIALS AND METHODS

Pyridoxamine-pyruvate transaminase was purified as described previously (Ayling and Snell, 1968) from *Pseudomonas* MA-1 which had been grown on pyridoxine as the sole carbon and energy source. The enzyme was crystallized four times from 45% ammonium sulfate solutions and had a specific activity of 21  $\mu$ moles pyridoxamine converted per min per mg protein at pH 8.85 and 25°.

Pyridoxal hydrochloride, pyridoxamine dihydrochloride, pyridoxine hydrochloride, and sodium pyruvate were purchased from Nutritional Biochemical Corporation. Pyridoxamine was recrystallized several times from methanol. L-alanine was purchased from CalBiochem Corporation. All other chemicals were reagent grade obtained from commercial sources.

The forward and reverse reactions (pyridoxamine consumption and formation, respectively) were assayed by a previously described spectrophotometric method (Ayling and Snell, 1968). The variation in extinction coefficient of pyridoxal was determined in the range pH 7-10 and used to standardize the assay at each pH studied. The forward reaction was also measured by the phenylhydrazine assay of Wada and Snell (1962a). All assays were started by addition of enzyme. In all cases the assays were linear with enzyme concentration and time (enzyme concentration: 2  $\mu$ g/ml; time:  $\leq 5$  minutes). Nonenzymatic transamination between pyridoxamine and pyruvate was negligible at the concentrations of these substrates used in the enzymatic reaction. Assay buffer was 0.050 M sodium pyrophosphate. The total variation in ionic strength in the range pH 7-10 was 0.21 M.

pH was determined after each assay using a Radiometer-Copenhagen Type PHM-4c pH meter, appropriately calibrated for temperature. Temperature was controlled ( $\pm 0.05^\circ$ ) during the pH variation studies by use of a water bath equipped with a Bronwill circulator and thermoregulator (Will Corporation, Rochester, N.Y.). In determining the effect of temperature on the kinetic parameters as a function of pH (see last part of Results section), the temperature was maintained using a Lauda K-2/R thermoregulator water bath.

Protein was determined spectrophotometrically (Ayling and Snell, 1968) and by the method of Lowry (Lowry et al., 1951), using bovine serum albumin as standard.

Unless otherwise indicated, the  $V_{\max}$  and  $K_m$  values in both the forward and reverse reactions were determined by the double reciprocal plotting method of Florini and Vestling (1957) as used previously by Ayling and Snell (1968). At each concentration of substrate at least four concentrations of cosubstrate were used in the determination of the corresponding point on the secondary plots.

## RESULTS

*Preliminary determination of enzyme stability and effect of pH and temperature on the initial velocities of reaction.* The effect of pH on the initial velocity of the forward and reverse reactions catalyzed by pyridoxamine-pyruvate transaminase is shown in Figure 1 (curves A and B, respectively). The pH optimum in both forward and reverse directions

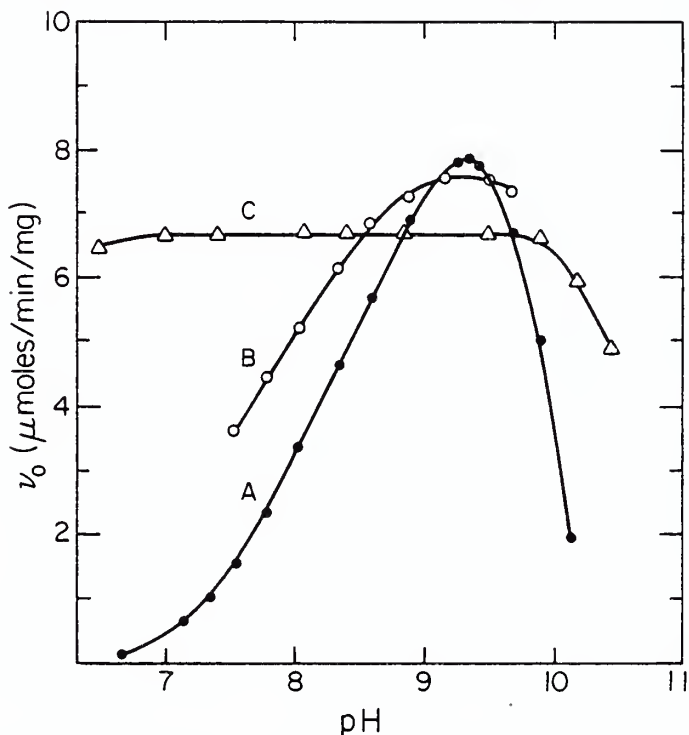


Figure 1. The effect of pH on the initial velocities and stability of pyridoxamine-pyruvate transaminase. Initial velocity in the forward reaction (pyridoxal formation or pyridoxamine consumption) at the several pH's (curve A) was measured by the phenylhydrazine assay; initial velocity in the reverse reaction (pyridoxal consumption or pyridoxamine formation, curve B) was determined by the spectrophotometric assay. In examining enzyme stability (curve C), enzyme (0.5-1.0  $\mu\text{g}$ ) was adjusted with dilute HCl or NaOH to the indicated pH, incubated for 20 minutes at 25°, readjusted to pH 8.85, and assayed by the phenylhydrazine method.

## Pyridoxamine-Pyruvate Transaminase

is 9.3. Curve C in Figure 1 indicates that the enzyme is stable for at least 20 minutes in the range pH 7-10. That the enzyme activity in the forward reaction is stable for 20 minutes in the temperature range 0-45° at pH 7.3 and pH 9.0 is shown in Figure 2. In the presence of excess pyridoxal ( $10^{-3}$  M) the enzyme is stable for 10 minutes at pH 7.0 and 70° (Wada and Snell, 1962b), a fact used to advantage in its purification. At pH 8.85 and 25°, the maximal velocity and Michaelis constants for the forward reaction (pyridoxamine consumption) are unaffected by pyrophosphate concentration in the range 0.025-0.050 M.

*The effect of pH on the maximal velocities and Michaelis constants for pyridoxamine-pyruvate transaminase.* The maximal velocity in the forward reaction ( $V_f$ ) increases with increasing pH to approximately pH 10, above which it falls abruptly (Figure 3). The decline in maximal velocity on the alkaline side of the optimum pH is probably due to irreversible inactivation of the enzyme (Figure 1). Michaelis constants

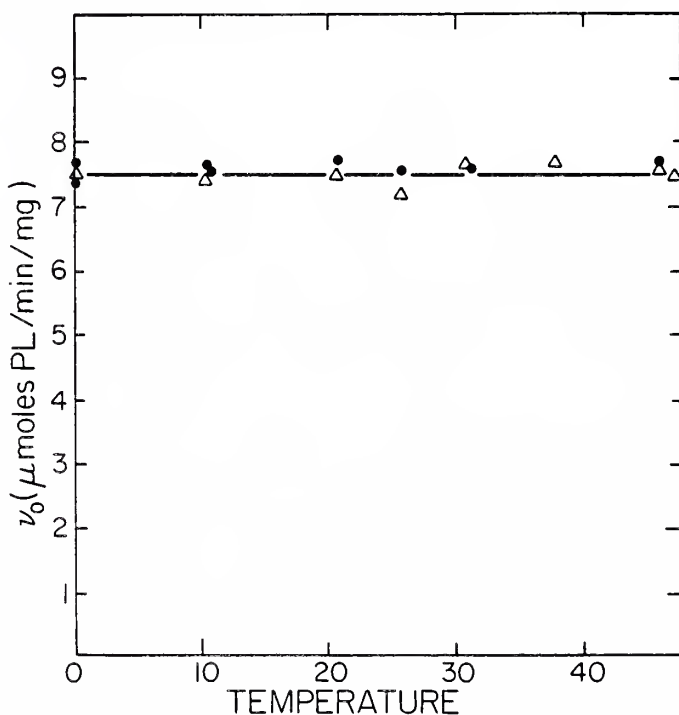


Figure 2. The effect of temperature and pH on the initial velocity of pyridoxal (PL) formation (pyridoxamine consumption) by pyridoxamine-pyruvate transaminase. Enzyme at pH 7.3 or 9.0 was incubated at the indicated temperatures for 20 minutes, then rapidly brought to 25° and assayed at pH 9.0. (●) Enzyme incubated at pH 9.0; (Δ) enzyme incubated at pH 7.3. Assays were by the phenylhydrazine method.

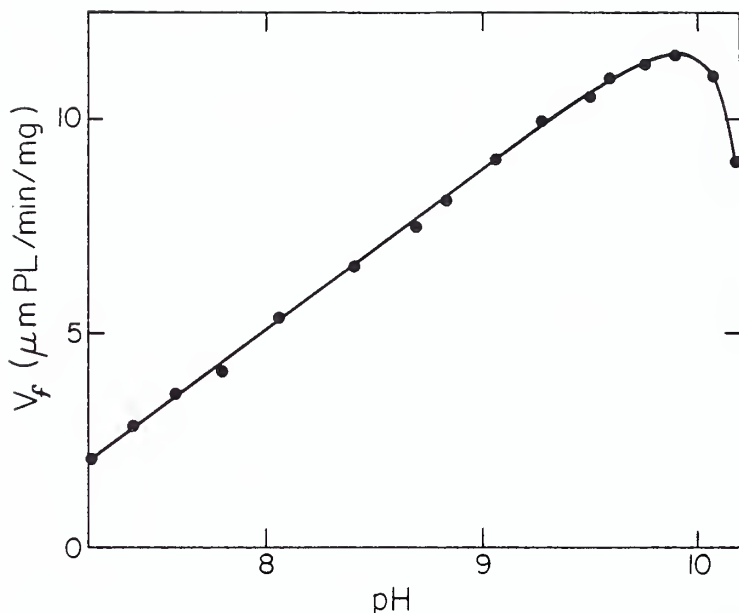


Figure 3. The effect of pH on the maximal velocity ( $V_f$ ) of pyridoxal (PL) formation (pyridoxamine consumption) by pyridoxamine-pyruvate transaminase. The spectrophotometric assay of Ayling and Snell (1968) was used.  $V_f$  values were obtained using the double reciprocal plotting method of Florini and Vestling (1957). This procedure also gave the Michaelis constants for pyridoxamine and pyruvate which are shown in Figure 4.

for pyridoxamine and pyruvate increase in the range pH 7-10 (Figure 4), the increase for  $K_m$  pyruvate being 250-fold. In Figure 5 the logarithms of the kinetic constants for pyridoxamine-pyruvate transaminase in the forward reaction are plotted as a function of pH according to the method proposed by Dixon (1953) and extended by Laidler (1958). The  $\log V_f$  against pH plot shows a bend centered at pH 8.3 (Figure 5A). A similar plot of  $-\log K_m$  pyridoxamine against pH has a slope of -0.31 and shows no change of slope in the range pH 7-10 (Figure 5B). A bend, centered at pH 8.3, was found upon plotting  $-\log K_m$  pyruvate against pH (Figure 5B, pyruvate). According to Dixon (Dixon and Webb, 1964), and as discussed below, the midpoints of the bends in these graphs indicate the  $pK_a$  of groups ionizing in the enzyme-substrate complex and in the free enzyme and substrates (Figure 5A and 5B, respectively).

The maximal velocities and Michaelis constants for pyridoxamine-pyruvate transaminase were also examined as a function of pH in the reverse reaction. The pH-dependent maximal velocity ( $V_r$ ) rises to a



# Pyridoxamine-Pyruvate Transaminase

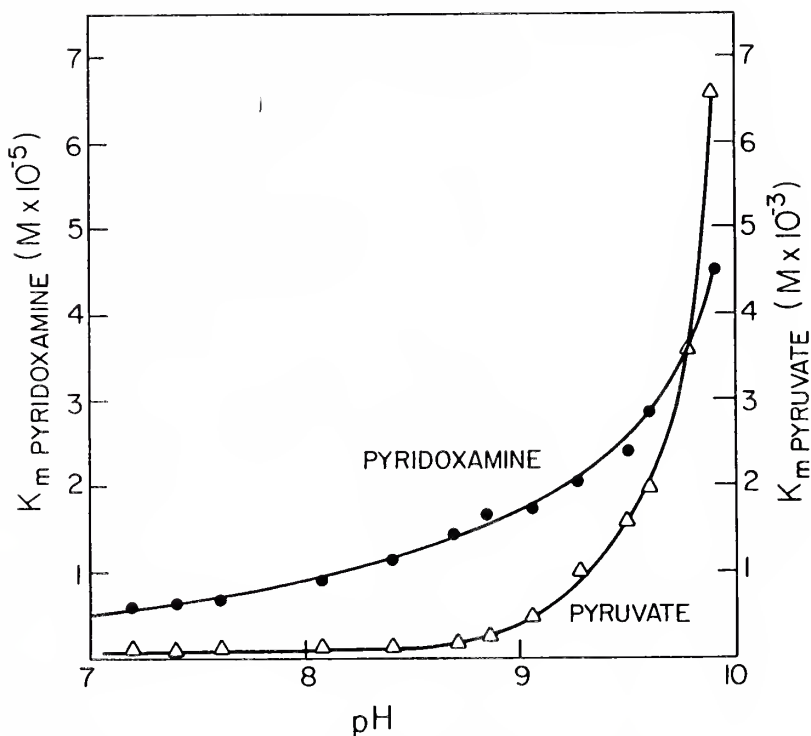


Figure 4. The effect of pH on the Michaelis constants ( $K_m$ ) for pyridoxamine and pyruvate of pyridoxamine-pyruvate transaminase in the forward reaction (pyridoxamine consumption).

maximum at pH 9.25, then declines (Figure 6A). The Michaelis constant for pyridoxal behaves similarly to that of pyridoxamine as a function of pH and shows a decrease in apparent affinity of these vitamin B<sub>6</sub>-cosubstrates as the pH is increased from 7 to 10 (Figure 6B). In contrast to the pH behavior of the  $K_m$  for the other substrates,  $K_m$  L-alanine decreases as the pH is raised. The  $\log V_r$  against pH plot shows a bend centered at pH 8.3 (Figure 7A);  $-\log K_m$  pyridoxal and  $-\log K_m$  L-alanine plotted against pH show no significant change in curvature (Figure 7B).

*Determination of the apparent heat of ionization of the group with  $pK_a$  8.3 involved in pyruvate binding in the forward reaction.* To better characterize the group found in pyruvate binding in the forward reaction, the  $K_m$  pyruvate against pH experiments were performed at several temperatures and the data at each temperature plotted according to the method of Dixon (Dixon and Webb, 1964); these data are shown in Figure 8. The change with temperature in the  $pK_a$  of the ionizing group in the enzyme was found by measuring the displacement of the midpoints of the

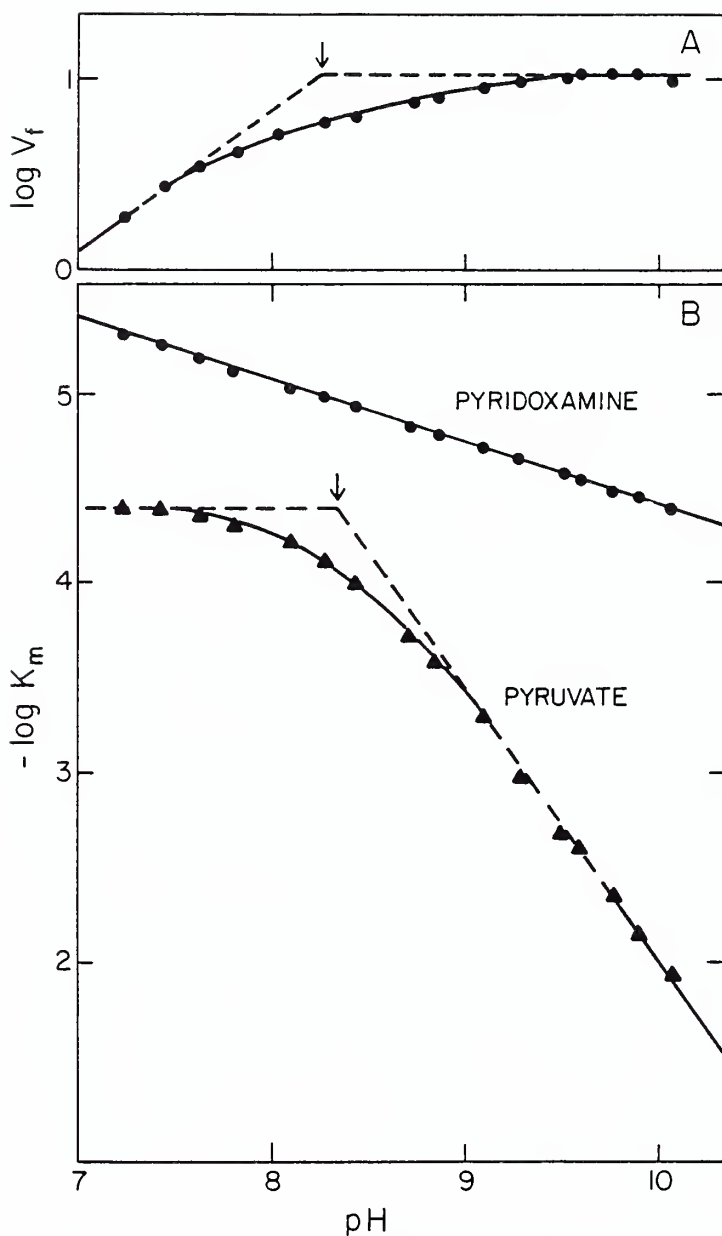


Figure 5. Graphs of  $\log$  maximal velocity ( $\log V_f$ ),  $-\log K_m$  pyridoxamine, and  $-\log K_m$  pyruvate against pH for pyridoxamine-pyruvate transaminase in the forward reaction. Data of Figures 3 and 4 are replotted as described in text.

# Pyridoxamine-Pyruvate Transaminase

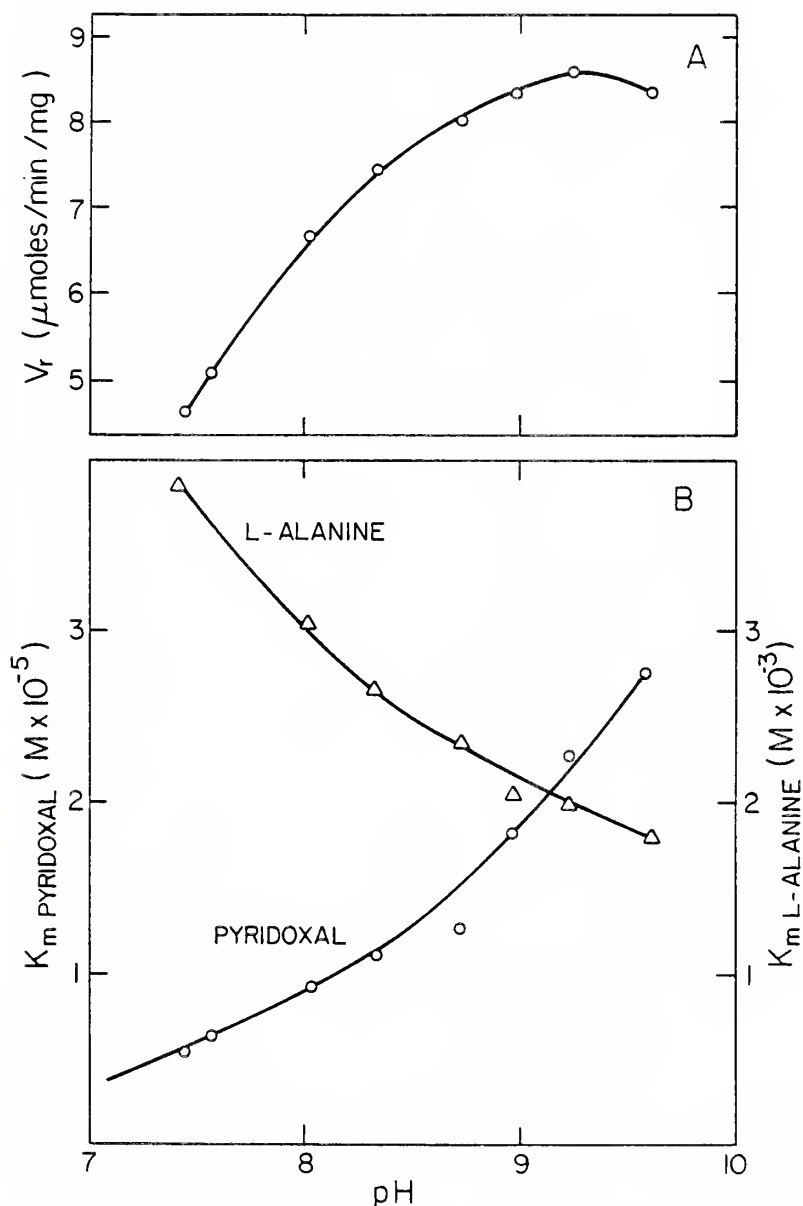


Figure 6. The effect of pH on the maximal velocity ( $V_r$ ) of pyridoxamine formation (Part A) and the Michaelis constants ( $K_m$ ) for pyridoxal and L-alanine (Part B). Enzyme was assayed by the spectrophotometric method of Ayling and Snell (1968). Other conditions are described in Methods section.

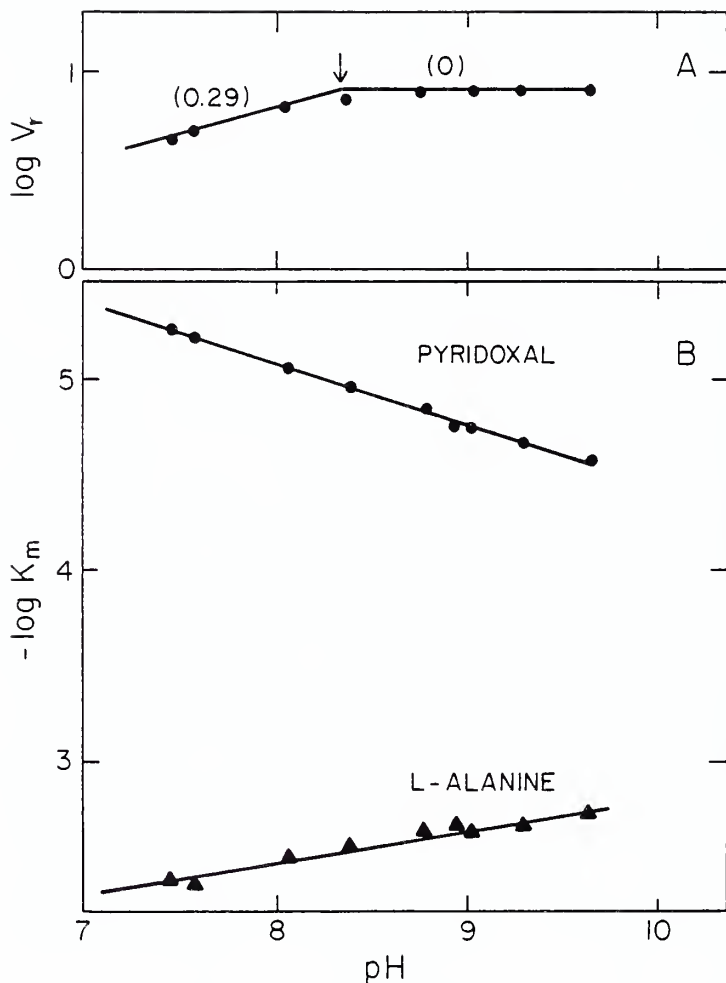


Figure 7. Graphs of log maximal velocity ( $\log V_r$ ),  $-\log K_m$  pyridoxal, and  $-\log K_m$  L-alanine against pH for pyridoxamine-pyruvate transaminase in the reverse direction (pyridoxamine formation). Data of Figure 6 are replotted as described in text.

# Pyridoxamine-Pyruvate Transaminase

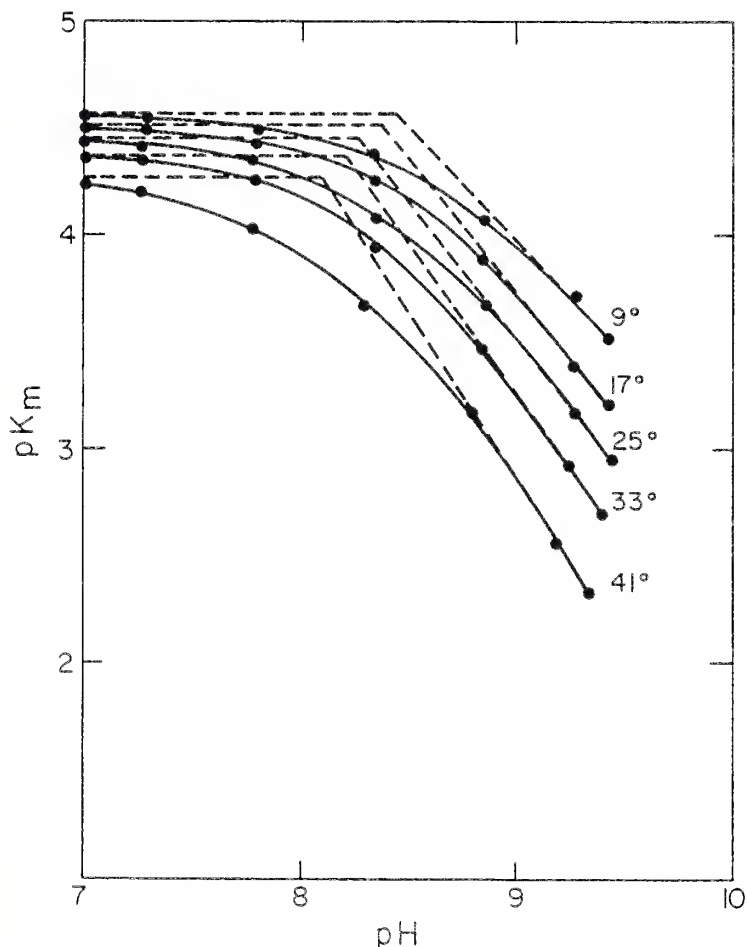


Figure 8. The effect of pH and temperature on  $-\log K_m$  pyruvate for pyridoxamine-pyruvate transaminase. Assays were performed using the phenylhydrazine method which employed a single saturating concentration of pyridoxamine (5 mM) at each pH and temperature. At each pH and temperature,  $K_m$  values were determined by the Lineweaver-Burke graphing method. At each temperature, straight-line portions of the  $-\log K_m$  against pH plot, when projected (indicated by dashed lines), intersect at points corresponding to the  $pK_a$  of the ionizing functional group involved in pyruvate binding. The effect of increasing temperature is seen to decrease the  $pK_a$  of this group.

bends. Using the van Hoff equation (Cohn and Edsall, 1943), the apparent heat of ionization was determined to be 4200 calories per mole (Figure 9). Because of the large number of assays needed in this determination,  $K_m$  pyruvate was obtained from Lineweaver-Burke graphs for pyruvate using a constant saturating concentration of pyridoxamine (5 mM), rather than the double reciprocal plotting method used in the above experiments. However, control experiments indicated that the enzyme was saturated with this cosubstrate at both extremes of pH and temperature used in this experiment.

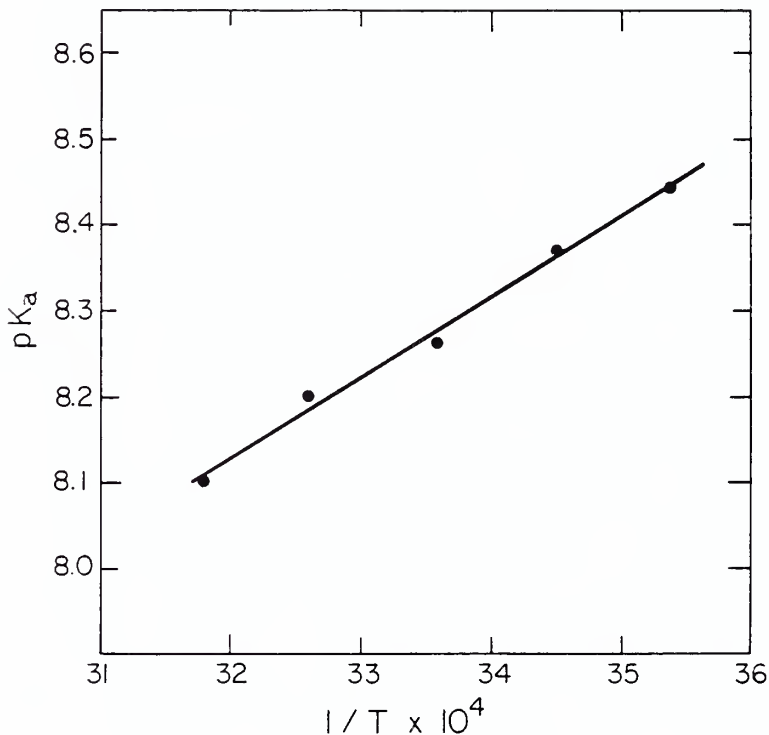


Figure 9. Determination of the apparent heat of ionization ( $\Delta H_i$ ) of the ionizing functional group with  $pK_a$  8.3 found in pyridoxamine-pyruvate transaminase when catalyzing the reaction in the forward direction. The several  $pK_a$  determined from Figure 8 are plotted as indicated.  $\Delta H_i$  was determined from the relationship

$$-\Delta H_i = \frac{\Delta 2.303 R \log K_a}{\Delta(1/T)}$$

in which  $R$  is the gas constant,  $T$  the absolute temperature, and  $K_a$  the ionization constant for the functional group. This expression is of course equivalent to that given in Table 1.

## Pyridoxamine-Pyruvate Transaminase

Table 1 is a list of  $pK_a$  values and apparent heats of ionization of common functional groups in model compounds which can be used as guides in possible identification of these groups in proteins. The values for the compounds designated reference (a) in the table were determined in the present study. By comparison of both  $pK_a$  and heats of ionization in Table 1 and elsewhere in the literature (Sober, 1968) with the values obtained for pyridoxamine-pyruvate transaminase, the enzyme functional group with  $pK_a$  8.3 involved in pyruvate binding is tentatively identified as sulfhydryl of protein-bound cysteine.

## DISCUSSION

In 1953 Dixon showed that if affinities of enzymes for substrates are determined as a function of pH and are expressed on a logarithmic scale, the data can be interpreted by simple rules which enable deductions to be made concerning the nature of functional groups ionizing in the enzyme-substrate complex, free enzyme, and substrates, as well as the ionization constants of these groups (Dixon, 1953). Although first applied to a simple equilibrium kinetic system, these rules were found to be valid for several steady state systems which were examined (Waley, 1953; Laidler, 1958; Dixon and Webb, 1964).

Graphing the data of the effect of pH on the kinetic parameters for pyridoxamine-pyruvate transaminase shows an ionizing group with  $pK_a$  8.3 in the enzyme-substrate complex for the reaction in both directions and a group in the free enzyme with  $pK_a$  8.3 involved in pyruvate binding in the forward reaction. For the latter group it should be realized that 'free enzyme' is actually pyridoxamine-bound enzyme; there is an ordered addition of substrates to enzyme in which the pyridine substrate adds first, followed by addition of the three-carbon substrate in the reaction in both directions (Ayling and Snell, 1968).

A full explanation of the nonintegral slopes seen in plots of  $\log V_{max}$  and  $-\log K_m$  against pH in the present study is not available at present. Nonintegral slopes were found in graphs of  $\log V_{max}$  against pH for histidine decarboxylase (Recsei and Snell, 1970). These have been interpreted to mean partial loss of charge upon dissociation of the substrate from the enzyme-substrate complex. In the present case, considering the pH effect on  $K_m$  pyridoxamine and  $K_m$  pyruvate, factors which affect pyridoxamine binding may well affect pyruvate binding and this may be reflected in the fact that slopes of  $-\log K_m$  against pH for both substrates deviate from an integral number by the same amount, 0.3.

Several possible enzyme-associated functional groups could give the  $pK_a$  8.3 seen in the present study for enzyme-substrate complex and free enzyme (Table 1): a) pyridoxamine and pyridoxal phenolic hydroxyl, b) protein  $\alpha$ -amino, and c) protein cysteinyl sulfhydryl. Any of these three groups could be that seen ionizing in the enzyme-substrate complex for the forward and reverse reactions.  $\epsilon$ -Amino group of protein-bound lysine may be eliminated as a possibility because of its high  $pK_a$  value. Cohn and Edsall (1943) have indicated that local environmental effects probably do not distort  $pK_a$  values more than 2 pH units even under the most extreme conditions. If one considers, in addition, the heats of ionization (Table 1), the group in free enzyme (again, actually



Table 1. Apparent  $pK_a$  values and heats of ionization of ionizing groups present in amino acids, peptides, and selected model compounds.

Compound and Ionizing Group	$pK_a$	$\Delta H_i$ (calories/mole)	Method	Reference
carboxyl ( $\alpha$ , in peptides)	3.0-3.2	1500	T	c
glutamic acid ( $\gamma$ -carboxyl)	4.3	1040	T	b
histidine (imidazolium)	6.0	6900	T	d
pyridoxamine (phenolic hydroxyl)	7.92	7500	T	a
pyridoxal (phenolic hydroxyl)	8.46	7800	T	a
2-mercaptoethanol (sulfhydryl)	9.45	4900	T	a
L-cysteine (sulfhydryl)	8.34	5000	T	a
2-mercaptobenzoic acid (sulfhydryl)	8.88	5700	C	d
3-mercaptobenzoic acid (sulfhydryl)	10.80	6100	C	d
2-mercaptoacetic acid (sulfhydryl)	10.65	6200	C	d
amino ( $\alpha$ , in peptides)	7.6-8.4	10,000-13,000	--	b
lysine ( $\epsilon$ -amino)	10.5	11,350	T	b

Apparent heats of ionization ( $\Delta H_i$ ) were determined through either temperature variation of  $pK_a$  (method T) or by calorimetry (method C).  $\Delta H_i$  were determined in the present study by the former method using the expression

$$\Delta H_i = -2.303 \times R T^2 dpK_a/dT$$

where  $dpK_a/dT$  is the slope of the graph of  $pK_a$  as a function of temperature. References are as follows: (a) determined in the present study, (b) Cohn and Edsall, 1943, (c) Dixon and Webb, 1964, and (d) Sober, 1968.

## Pyridoxamine-Pyruvate Transaminase

pyridoxamine-bound enzyme) participating in pyruvate binding is probably cysteinyl sulfhydryl, although phenolic hydroxyl of the pyridine substrate should not be completely ruled out. Amino acid analyses (Dempsey and Snell, 1963) and inhibition studies (Fujioka and Snell, 1965) have shown sulfhydryl groups to be present in pyridoxamine-pyruvate transaminase and required for its catalytic activity. In addition, in every case examined to date, vitamin B<sub>6</sub>-enzymes require intact sulfhydryl groups for enzymatic activity. Whether enzyme-associated ionizing groups with pK<sub>a</sub> 8.3 will be found in other pyridoxal or pyridoxal phosphate-requiring enzymes remains to be determined. Ionizing groups with pK<sub>a</sub> 7.6 and 8.5 have been found in the enzyme-substrate complex and free enzyme, respectively, for rat liver kynureninase (Ford, unpublished data).

### ACKNOWLEDGEMENTS

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REPRODUCTION AND ACTIVITY OF THE GREATER SIREN,  
*Siren lacertina* (AMPHIBIA:SIRENIDAE),  
IN ALABAMA<sup>1</sup>

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Data were obtained from September, 1972, through June, 1975, on the activity and reproductive cycle of a population of *Siren lacertina* in Hutto Pond near Abbeville, in Henry County, Alabama. The known range of this large, aquatic amphibian is the Coastal Plain from the District of Columbia southward to southern Florida and westward into Alabama. In Alabama the greater siren is known from only two localities (7), the locality of the population studied and one in Baldwin County.

Hutto Pond, 2.8 ha in size, is in southeastern Alabama near the northern edge of the Lower Coastal Plain herpetofaunal region (7). It is fed by several seepage springs and one intermittent stream and averages approximately 1.2 m in depth. Approximately two-thirds of the pond is open water, and one-third is occupied by emergent vegetation commonly found in the margins of swamps and streams in the area. These include *Nyssa sylvatica*, *Salix nigra*, *Cephalanthus occidentalis*, *Juncus* spp., *Typha* sp., *Carex vulpinoidea*, and *Potamogeton pectinatus*.

Little is known of the natural history of *S. lacertina* (6). Several authors have noted that sirens are more active at night than during the day (3, 10, 2). Carr (1) reported finding greater sirens encapsulated in the mud during periods of drought.

Knowledge of the reproductive cycle of this species is especially fragmentary. Willett (12) discussed and illustrated the male reproductive system. She stated that the testes are bilaterally asymmetrical in position, the right being anterior to the left, and in size. Size differences were not discussed. She further stated that sperm develop within series of amullae, which are absorbed when the sperm are discharged.

Salthe (9) described the eggs of *S. lacertina*, and Neill (8) compared the juveniles of *S. intermedia* and *S. lacertina*. Sexual dimorphism

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has not been reported in greater sirens. Ultsch (11) summarized the available information of the reproductive habits of *S. lacertina*. On the basis of field observations he suggested that in Florida greater sirens congregate in the shallow water of lakes or streams for breeding in February and March. He also concluded that fertilization is external and that eggs are laid singly or in small groups.

#### METHODS AND MATERIALS

Attempts were made to collect specimens monthly. On each visit air and water temperatures were recorded with a mercury thermometer. Water temperatures were taken at the western margin of the pond at a depth of .5 m.

Several techniques were used in collecting. At night, adult sirens were caught on hooks (sizes 1, 2, 4, and 6) baited with pork or beef liver, minnows, and pieces of mullet, eels, or catfish. All areas of the pond were sampled using 25-hook trotlines, juglines, and droplines hung from overhanging branches. Modified funnel fish traps proved unsuccessful, as did day and night seining with a 10-foot minnow seine and 30-foot bag seine. Rotenone-collecting in small areas, tried during daylight hours, proved ineffective.

Specimens were killed by submergence in a choretone solution immediately after capture. The specimens were then injected with 10% formalin and were allowed to fix for 4 to 5 days. Preserved specimens were placed in the herpetology collection of the Auburn University Museum. Some specimens were brought back alive to the laboratory and kept in aquaria for observation.

Forty-two specimens were preserved and examined, 33 of which were used for studies of the reproductive cycle. The sex of each specimen was recorded. Weights of the preserved animals were taken to the nearest decigram on a platform balance. Linear measurements were made with vernier calipers or a standard meter stick. The following linear measurements were taken:

Total length--maximum straight-line distance from the tip of the snout to the posterior tip of the tail.

Snout-vent length--maximum straight-line distance from the tip of the snout to the anterior edge of the anal opening.

Head length--maximum straight-line distance from the tip of snout to a mid-ventral point opposite the anteriormost portion of the first gills.

Width between eyes--minimum straight-line distance between the eyes.

Ovaries and testes were removed and measured linearly with a vernier caliper or a metric rule and volumetrically by the water displacement method. They were fixed in a 10% formalin, labeled, and preserved in 70% ethanol. Testes were later cross-sectioned at a thickness of 6

## *Siren lacertina* in Alabama

microns and stained with hematoxylin and eosin (5) to study seasonal changes in gonads. Some ovaries were dissected, and the ovarian follicles counted and measured. Oviducts were examined for oviducal eggs.

### RESULTS

#### Sex Ratio and Sexual Dimorphism

Our sample consisted of 25 males and 17 females. The difference was not significant at the 5% level.

Sexual dimorphism has not been reported in *S. lacertina*. Frederick Gehlbach (pers. comm.) observed a dimorphic trait in *S. i. intermedia* and *S. i. texana*. He stated that in males of these forms weighing more than 40 grams, the masseter muscles were enlarged, imparting a somewhat swollen appearance to the back of the head. By contrast, the masseter muscles of females were not enlarged. Also, the males' tails were said to grow more slowly in large individuals.

The character of differential tail growth was not evident in *S. lacertina*. However, enlargement of the masseter muscles was noticeable in all males examined. Moreover, the overall head size in the males appeared greater than in females of comparable sizes. Actually, the heads of males proved to be relatively shorter than those of females, conveying the relatively more massive appearance.

For a given specimen, a numerical value for the sexually dimorphic character may be derived by dividing head length by width between the eyes. The ratio in most males is less than 2.30 (mean--2.22), and in most females greater than 2.30 (mean--2.43). Of 42 specimens examined, only three (one female and two males) did not conform. These specimens were among some in which the head shape was distorted during fixation, perhaps causing erroneous measurements. All specimens examined were sexually mature. It is not known whether this character is useful in determining the sex of immature specimens or of individuals from other populations.

#### Testicular Changes

In the males of our sample, the right testis was larger in some individuals, and the left was larger in others. The testes were largest in early spring, decreased in size rapidly in late spring, and increased in the summer and fall. Testis volume and width increased with testicular activity, whereas length decreased (Fig. 1).

Following is a generalized description of spermatogenesis in the right testis. In April, 1973, spermatogenesis had been completed, and only a few spermatozoa remained in the large lumina of the seminiferous tubules (Fig. 2a). One month later the seminiferous tubules were small, the lumina indistinct, and the only germinal cells were spermatogonia (Fig. 2b). Proliferation of spermatogonia continued through June and July (Fig. 2c). In August spermatocytes were apparent, and the lumina had begun to enlarge. In September mitotic divisions of spermatogonia were decreasing, and there were increased numbers of spermatocytes. The

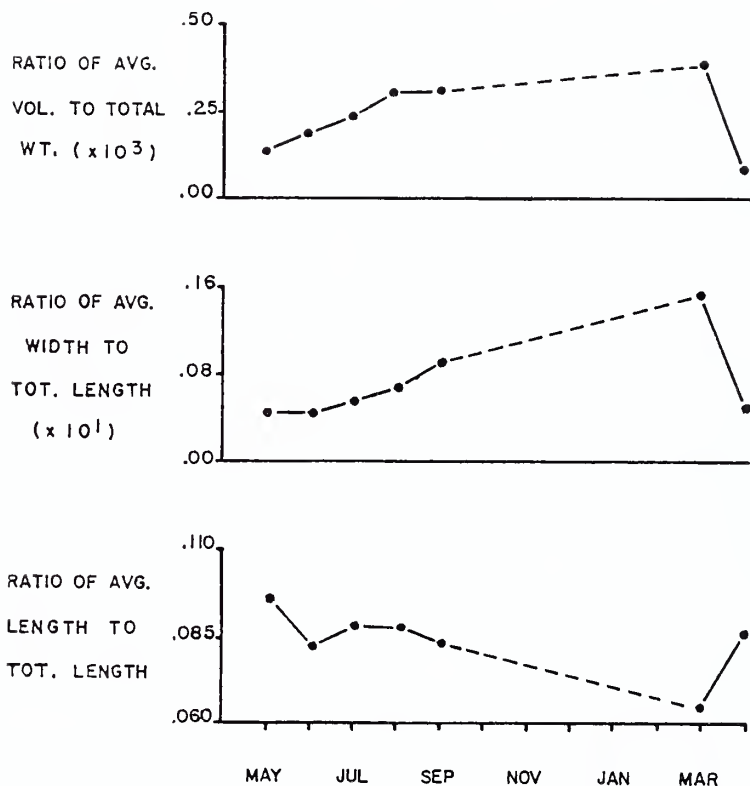


Figure 1. Seasonal variation from 1973 to 1974 in the ratio of length, width, and volume of testes to total length or weight.

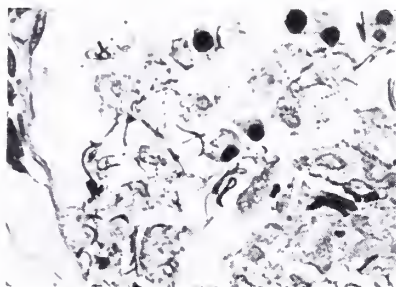
lumina were small, and spermatids and spermatozoa were absent (Fig. 2d). Male specimens were not collected again until March, 1974, at which time the lumina were large and engorged with spermatozoa. No other germinal proliferation was apparent (Fig. 2e). One month later the lumina were smaller, few spermatozoa remained, and cellular proliferation was not apparent. Spermatozoa were found only in the vasa efferentia of the specimen collected March 7, 1974.

#### Female Gonadal Changes

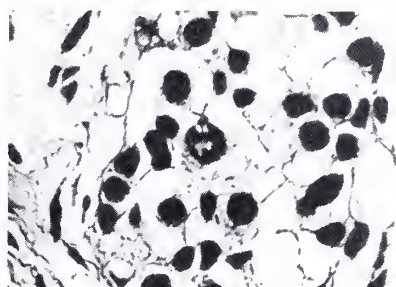
Ovaries are lobed and bilaterally asymmetrical in position and size. The right ovary is slightly anterior to the left. In most specimens the left ovary was longer than the right. However, this tendency was not noted in width and volume measurements.



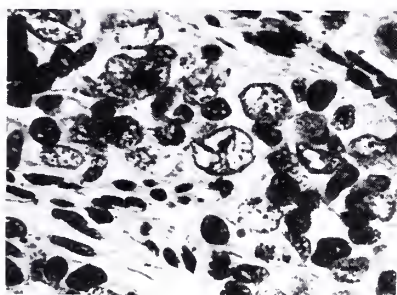
*Siren lacertina* in Alabama



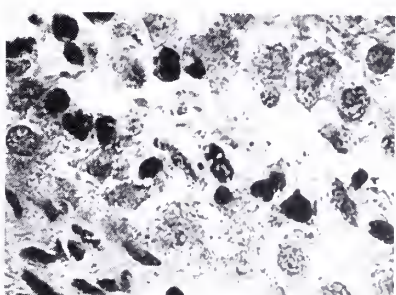
(a)



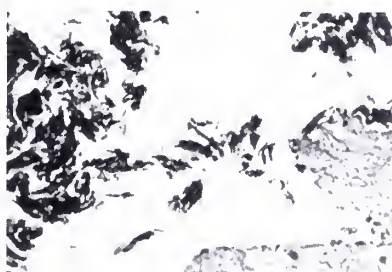
(b)



(c)



(d)



(e)

Figure 2. Seasonal variation in testicular activity as shown by a cross-section of a seminiferous tubule in the right testis of *Siren lacertina* collected on (a) April 10, 1973, (b) May 11, 1973, (c) July 3, 1973, (d) September 11, 1973, and (e) March 7, 1974.

Following is a generalized discussion of seasonal changes in volume and follicular development in the right ovary (Fig. 3). The females from which the ovaries were removed all measured over 500 mm in length, with the exception of the specimen captured on January 25, 1975, which measured only 404 mm.

In April, 1973, the ovarian volume was 0.8 ml, and the largest follicle at that time measured 2.18 mm in diameter. In January, 1974, the mean ovarian volume was 11.2 ml. The largest follicle measured 4.70 mm in diameter. All follicles were over 3.00 mm. The eggs were yolked and pigmented at one pole, apparently nearly ready for deposition. Six weeks later in March, 1974, the mean volume had decreased to 1.4 ml, and the largest follicle to 4.40 mm. However, very few follicles 4 mm or greater were observed, with most being 1 to 2 mm in diameter. No oviducal eggs were found in any of the specimens, although the oviduct was greatly enlarged in the specimens collected in January. No spermatozoa were found in any of the females' tracts.

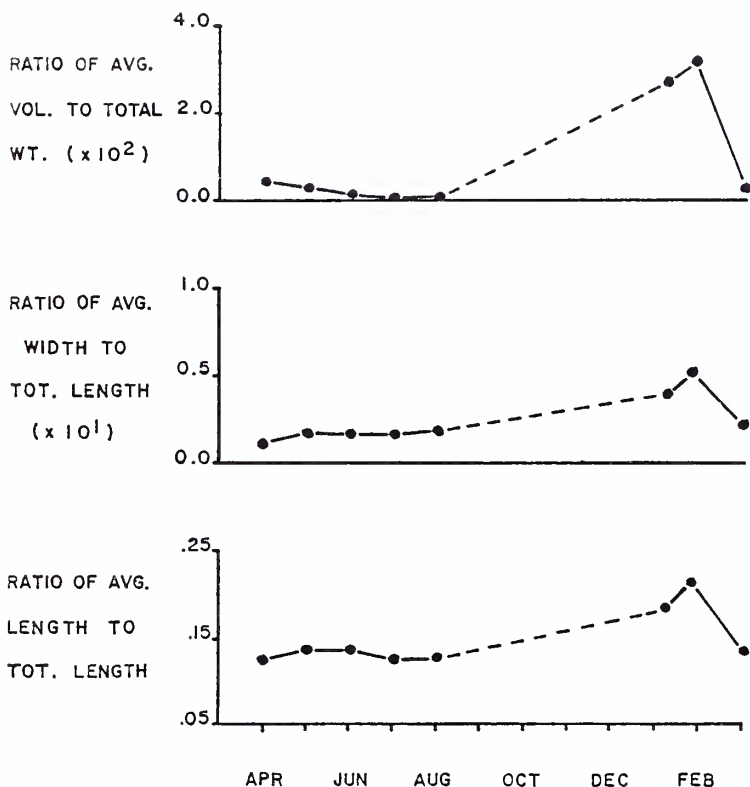


Figure 3. Seasonal variation from 1973 to 1974 in the ratio of length, width, and volume of ovaries to total length or weight.

## *Siren lacertina* in Alabama

### Eggs and Breeding Habits

Whether fertilization in sirens is internal or external has not been determined with certainty. No courtship or mating behavior was observed during this study. Attempts to collect eggs were unsuccessful and no eggs were deposited by captive specimens. The ovaries of a female collected January 25, 1974, contained about 1,400 enlarged ovarian follicles which were yolked and pigmented at one pole, indicating a high reproductive potential.

### Larvae

Our efforts over a 3-year period to find larvae of *Siren lacertina* at Hutto Pond were unsuccessful. This is surprising considering the number of adults observed and collected. It is equally surprising that *Siren lacertina*, a smaller, more widely distributed species, was not discovered in the pond until May, 1975, when eight small larvae (total length 42 to 63 mm) and one large larva (total length 113 mm) were collected. The small larvae resembled those of *S. intermedia* described by Neill (8), except that they lacked red markings on the posterior portion of the caudal fin. They had 32 to 33 costal grooves.

The large larva collected could be mistaken for that of *S. lacertina*. It was fairly stout and profusely speckled with yellow chromatophores. The chromatophores were more abundant on the venter, and they extended in a concentrated patch from the corner of the mouth to the gills on each side. Although the ground color was dark brownish olive, tiny black flecks were visible on the head and dorsum. Costal grooves numbered 33.

Small adults of *S. lacertina* from Hutto Pond exhibit the yellow speckling, including the patch of yellow chromatophores extending from the mouth to the gills. Costal grooves on the adult *S. lacertina*, however, number 36 to 39 (mean = 37).

### Activity

Greater sirens in Hutto Pond were active from dusk to dawn, with peaks of activity occurring within a 2-hour period following darkness and another within a 2-hour pre-dawn period, as determined by observations and fishing success.

A seasonal peak of feeding activity was indicated during June and July, when the water temperature was about 28°C, and the water level of the pond was normal. Activity decreased in August and September, when the water temperature had reached a mean of about 29°C and the water level dropped to about .3 m below normal.

In October the water temperature dropped to about 22°C, and sirens were neither caught nor seen in the pond. This apparent lack of feeding activity continued through December, when the water temperature had declined to about 11°C.

In January, following a warming period, the water temperature rose to 17°C, and sirens were again caught. In February, although the water

temperature was about 18°C, no sirens were collected or observed. However, in early March the water temperature reached about 20°C, and collecting was again successful.

At no time during this study did Hutto Pond dry up. However, during August, 1969, following a drought, the pond decreased to about 0.5 ha in size. At this time one end of the pond was deepened with a bulldozer, and approximately 100 sirens were unearthed (Walter Kelly, pers. comm.). The sirens were encapsulated in the mud in a manner similar to those reported by Carr (1).

#### SUMMARY AND DISCUSSION

Spermatogonia become evident in the testicular tubules of male *Siren lacertina* in the spring. Mitotic divisions of the spermatogonia continue until primary spermatocytes are abundant in early fall. Spermatogenesis continues during a period of relative inactivity on the part of the sirens and terminates in the production of spermatozoa in late winter. During the period February-March the spermatozoa are released. The ampullae bearing any remaining sperm are absorbed, and the cycle is repeated.

In females, oogenesis begins in late spring, with follicular proliferation and enlargement continuing through the summer and through the period of fall inactivity. Oogenesis is completed in late winter (February to early March), at which time eggs over 4 mm in diameter are presumably deposited. Any remaining ova are absorbed. Our observations thus support the hypothesis (11) that breeding occurs in February or March.

Neill (8) and Duellman and Schwartz (4) reported collecting larvae of *S. lacertina* in late spring or early summer. The only siren larvae we collected in Hutto Pond during the present study were those of *S. intermedia*.

*Siren lacertina* in Hutto Pond are nocturnal with peaks of activity occurring within 2 hours after dark and 2 hours before dawn. Seasonal activity appears to be affected to a considerable extent by temperature changes. Sirens are active in the spring and summer when the water is warm. A period of quiescence is initiated by a sharp decline in water temperature in the fall and is terminated by a sharp increase in water temperature the following winter or early spring, at which time breeding apparently occurs.

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## WATER QUALITY OF CATOMA CREEK AND OTHER SELECTED WATERS IN NORTHERN MONTGOMERY COUNTY<sup>1</sup>

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### INTRODUCTION

The northern half of Montgomery County is rich in lotic waters, including the Tallapoosa and Alabama Rivers and numerous creeks ranging in size from large creeks such as Line Creek and Catoma Creek to small streams with flow restricted to periods of high runoff produced by heavy rain. Relatively little is known about water conditions in most of the creeks. Although the Alabama Water Improvement Commission maintains monitoring stations where data are gathered on physical and chemical conditions at fixed locations in the rivers, there has been insufficient funding for systematic studies of smaller streams. The present study was undertaken to determine selected aspects of water quality in a sample of creeks in northern Montgomery County. Several physical and chemical parameters bearing on water quality were measured and additional tests were conducted for coliform bacteria.

### METHODS

This report covers data collected during the period March 15 to August 18, 1977. Early in this period, several bodies of water were sampled once each in an initial screening for conditions indicative of pollution. Water was sampled at Line Creek, Miller Creek, Galbraith Mill Creek, at the overflow of Froggy Bottom Pond, and at an unnamed creek crossing Wares Ferry Road just west of Mt. Meigs Station. Subsequent efforts were restricted to Catoma Creek.

#### Sampling Sites

Line Creek was sampled at Interstate 85 on March 15. Samples were taken from Miller Creek on March 17 at the crossing of Western Railway of Alabama. On March 24 data were collected at the overflow of Froggy Bottom Pond on Wares Ferry Road. The unnamed creek just west of the Mt. Meigs Station on Wares Ferry Road was sampled on April 4. Galbraith Mill Creek was sampled at its northern crossing of Lower Wetumpka Road on April 12. Beginning on April 28, samples were collected weekly from Catoma Creek at Mobile Highway (U.S. 31). The only exception was that no samples were taken during the week of June 9.

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<sup>1</sup>Manuscript submitted 5 September 1977; accepted 12 October 1977.



## Water Quality of Catoma Creek

### Parameters Measured

For most samples the following data were recorded: Water temperature ( $^{\circ}\text{C}$ ), dissolved solids ( $\text{mg/l}$ ), turbidity (formazin turbidity units--FTU), apparent color (APHA platinum-cobalt color units), pH, nitrate nitrogen ( $\text{mg/l}$ ), orthophosphate ( $\text{mg/l}$ ), total hardness ( $\text{mg/l}$ ), and calcium hardness ( $\text{mg/l}$ ). Counts of coliform bacteria and human fecal coliforms were made in many cases. These data are reported as most probable number (MPN) of coliforms per 100 milliliters. Turbidity, apparent color, pH, orthophosphate, total hardness, calcium hardness and coliform bacteria were measured with equipment purchased from and by methods described by the Hach Chemical Company (1973, 1976). All colorimetric tests were performed using the Hach DR-EL/2 spectrophotometer. The tubes for human fecal coliform bacteria were incubated at  $44.5^{\circ}\text{C}$  by the Hach Model 15320 Bacterial Incubator. Dissolved solids were measured by a Myron L. Deluxe DS Meter, model 512T5.

### RESULTS AND DISCUSSION

Data from the various water bodies except Catoma Creek are shown in Table 1. Although no visual signs of pollution were detected, high nitrate and phosphate levels are indicated in all of these waters. Measurements were restricted to the spring, a period of high fertilizer runoff. There is little reason to suspect severely detrimental inputs of effluents at other times of the year. However, Line Creek and, to a lesser extent, Miller Creek and the creek near Mt. Meigs Station may be subject to runoff from agricultural sources--fertilizers and pesticides--in the later spring and summer months. There are currently no major industrial plants releasing chemicals into these waters, but Miller Creek receives a channel designed to carry cooling water from a large silicon plant and further industrialization may be expected in Mt. Meigs. Froggy Bottom Pond may receive seepage from housing developments which have closely approached it on two sides, but this may be of little import as the pond's future is in doubt. The owner has dynamited the dam, causing the water level to drop several feet.

The various streams showed similar values on most of the variables measured. Nitrate nitrogen varied only between 3 and 4  $\text{mg/l}$ , with no value recorded for Line Creek. Orthophosphate levels were also consistent, ranging from 0.2 to 0.4  $\text{mg/l}$ . No phosphate measurement was made for Line Creek. The pH was close to neutral in all samples with a low of 6.7 in Galbraith Mill Creek to highs of 7.0 at Froggy Bottom Pond and Line Creek. The waters measured are quite soft, having total hardnesses between 20 and 40  $\text{mg/l}$ . Dissolved solids were likewise present in low concentrations. All values were below 100  $\text{mg/l}$ .

Turbidity, apparent color, and water temperature were more variable. As expected, water temperature showed an increasing trend with time for these data collected between mid-March and mid-April. Turbidity often rises during periods of high flow, largely due to suspended materials carried to the channel in runoff water. It is therefore subject to large fluctuations. Turbidity values in this portion of the study were all appreciable, ranging from a low of 40 to a high of 90 formazin turbidity units. This high turbidity occurred on March 15 at Line Creek.



Table 1. Water quality data for several bodies of water in northern Montgomery County.

	Date	H <sub>2</sub> O Tempera- ture (°C)	Dissolved Solids (ppm)	Apparent Color (Pt-Co units)	Turbidity	pH	Nitrate N(mg/l)	Ortho- phosphate (mg/l)	Total Hardness (mg/l)
Line Creek	3/15	16	60	290	90	7.0	-	-	40
Miller Creek	3/17	17	70	120	40	6.8	4	0.30	-
Froggy Bottom Pond	3/24	18	40	265	80	7.0	3	0.40	20
Mt. Meigs Station Creek	4/4	18	50	190	60	6.9	4	0.30	20
Galbraith Mill Creek	4/12	21	50	200	60	6.7	3	0.25	30

## Water Quality of Catoma Creek

On this date Line Creek was swollen well beyond its normal flow with runoff from recent heavy rains. Apparent color may be associated with high turbidity and thus with high flow rates. The two highest levels of apparent color, 290 and 265 platinum-cobalt units, were recorded at Line Creek and Froggy Bottom Pond, the sites of highest turbidity. The lowest measured apparent color, 120 platinum-cobalt units, was at Miller Creek, which also had the lowest turbidity. Using a one-tailed test for the hypothesis that turbidity and apparent color are positively associated, the Spearman rank correlation coefficient of 1.0 is significant at  $\alpha = .05$ .

Tests were conducted for the presence but not the density of coliform bacteria in all creeks. Coliforms were detected at all locations except Line Creek.

From the small amount of data available, it is not possible to draw conclusions regarding long-term water quality trends in Line Creek, Miller Creek, Galbraith Mill Creek, or the creek near Mt. Meigs Station. However, the data provide evidence of abnormally high phosphate and nitrate levels on the sampling dates. Except for Froggy Bottom Pond, these waters visually appear to be relatively unpolluted. At Froggy Bottom Pond visual evidence of pollution has been noted on many occasions by one of the authors (Cooper). Refuse is often dumped into Froggy Bottom Pond near the dam by Wares Ferry Road. At times small amounts of oil are visible on the surface, but this is not a chronic condition.

The first samples at Catoma Creek revealed several differences between the water of Catoma Creek and the previously sampled waters. Dissolved phosphate concentrations were over 10 times higher in Catoma Creek, total hardness and dissolved solids were over twice as high, and pH was somewhat elevated. Examination of data collected during the following four months showed that some of the differences were transitory, particularly those in phosphate concentration and pH.

Phosphate levels (Fig. 1) were elevated on 4/28 and 5/5 but fell steadily to the levels found in the other waters by early June. These lower, but still high, concentrations were maintained through the remainder of the study period. From the high initial values of 4.9 and 7.1 mg/l, orthophosphate concentration declined to 0.3 mg/l by 6/2 and remained at that level until late July. In early August, a slight increase occurred, peaking on 8/4 at 0.6 mg/l. The highest observed phosphate levels were associated with periods of relatively high flow. Although no measurements of flow rates were made, it was noted that flow was high from spring rains in late April and early May. Flow declined during the drought in early summer, but increased again in late July and early August, a period of increased rainfall. In late summer, the highest flow occurred on 7/28, a week before the date on which the greatest increase in orthophosphate concentration was detected. No known point sources of phosphate pollution are located on Catoma Creek upstream from the sampling site. It seems likely that increased phosphates are derived from terrestrial surface sources, i.e., they come into the stream in runoff water. The source may be a combination of detergents, fertilizers, and pesticides.

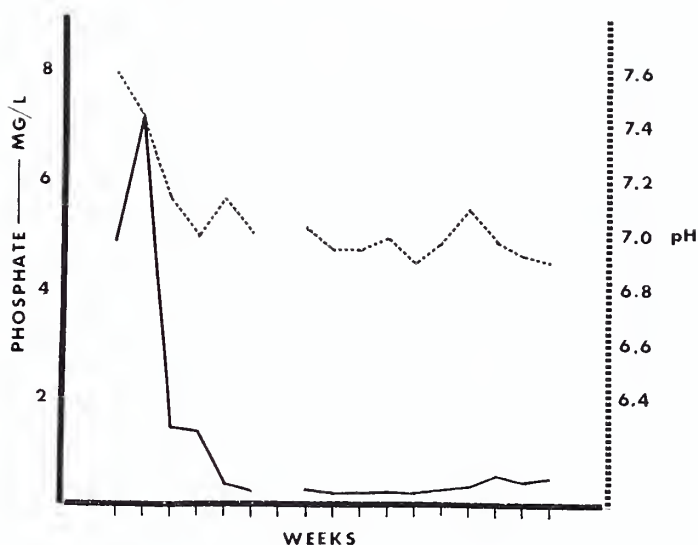


Figure 1. Orthophosphate concentrations and pH for Catoma Creek at weekly intervals beginning 4/28 and ending 8/18. No data were collected on 6/9.

The water of Catoma Creek remained nearly neutral throughout the summer (Fig. 1), varying only from 6.9 to 7.6. The highest pH was recorded in the first sample on 4/28. By 5/12, the pH had fallen to 7.1. Thereafter, pH remained between 7.1 and 6.9.

Catoma Creek had considerably higher hardness than the other waters studied. Total hardness values were between 80 and 160 mg/l (Fig. 2). In comparison, the other waters showed hardness between 20 and 40 mg/l. Catoma Creek's higher hardness may be attributable to the type of soil and subsoil in its drainage area. The soil in Catoma Creek's drainage is primarily Lucedale-Bama and Sumter-Iktibbeha-Leeper. The drainage areas of the other waters include these soils, but the others all traverse Cahabe-Chewacla-Myatt soil (USDA General Soil Map, State of Alabama, 1974). The drainage of Catoma Creek is notably less siliceous than those of the other waters (Soil Survey, Montgomery County Alabama, 1960). The elevation of hardness to 160 mg/l on 5/26 cannot be explained by the available data. However, a point source may be implicated since there was no notable change in flow at that time. Measurements of calcium hardness (Fig. 2) revealed that the large majority of total hardness is due to calcium. The maximum hardness not due to calcium was 15 mg/l. Therefore the curve closely corresponds to that for total hardness.

## Water Quality of Catoma Creek

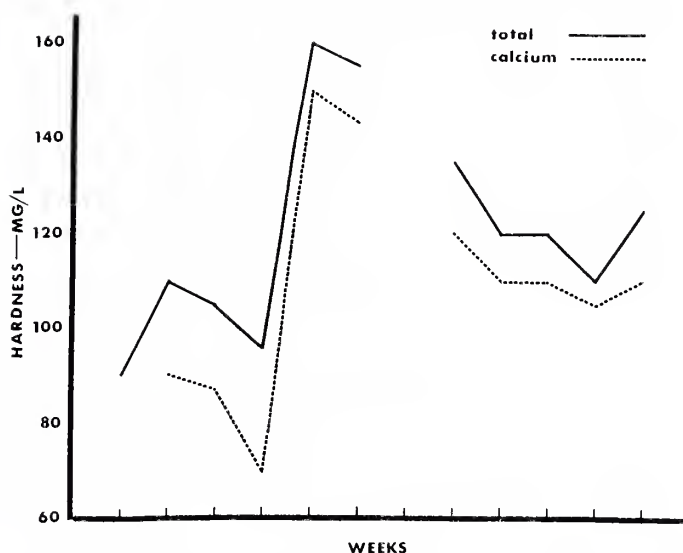


Figure 2. Total and calcium hardnesses for Catoma Creek, expressed as milligrams of calcium carbonate per liter. Data are recorded weekly from 4/28 to 8/18, with the exception that no data are available for 6/9.

Dissolved solids were consistently more concentrated in Catoma Creek than in the other waters. Dissolved solid concentrations were generally less than 100 ppm in all samples except those from Catoma Creek (Fig. 3), in which levels of about 200 ppm were the norm. A temporary increase to 300 ppm occurred on 5/19 and a decrease to 100 ppm was recorded on 7/28. This decrease was associated with large increases in apparent color and turbidity which accompanied the high flow after heavy rainfall.

Apparent color in Catoma Creek (Fig. 3) was lower than in the other waters on most dates, but the differences may reflect seasonal changes in the water content rather than true differences among creeks. The other creeks (except Miller Creek) showed relatively high color values. However, Catoma Creek had declining apparent color values over the first month of study. Starting at over 140 Pt-Co units on 4/28, apparent color decreased to about 60 units by 6/2. The other water bodies may have undergone similar changes. Through June and the first half of July, apparent color remained at low levels between 60 and 40 units. During the high flow on 7/28, apparent color increased by an order of magnitude to 500 units. Thereafter, it declined rapidly to 60 units by 8/11.

Like apparent color, turbidity in Catoma Creek (Fig. 4) was initially lower than in the other waters except Miller Creek. Turbidity also showed decreasing levels during May, declining from over 40 FTU on 4/28

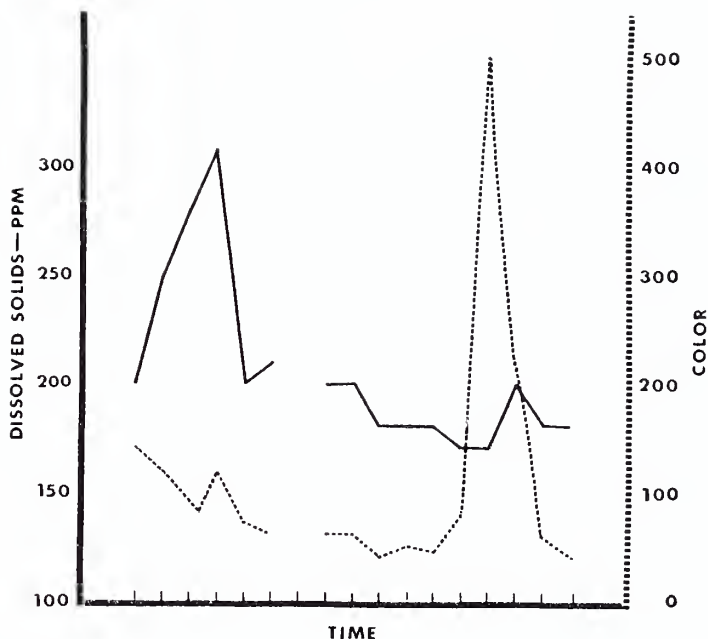


Figure 3. Dissolved solids in parts per million = milligrams per liter and apparent color in APHA Pt-Co units are shown for Catoma Creek at weekly intervals from 4/28 to 8/18. Data for 6/9 are lacking.

to 20 FTU on 5/26. Thus, differences between creeks may reflect merely differences in conditions on the dates of measurement. Between 5/26 and 7/21 turbidity remained near 20 FTU. Flow was reduced during this interval. Following the heavy rains in late July, turbidity jumped to 140 FTU on 7/28. By 8/11, turbidity returned to 20 FTU.

Nitrates were present in Catoma Creek (Fig. 4) at levels initially similar to those measured elsewhere, but subsequently declined to lower values. From a high of 5 mg/l on 5/5, nitrate nitrogen decreased to the 2 mg/l which was recorded on the next three weeks. Thereafter, nitrate nitrogen varied little, remaining between 0 and 1 mg/l for the remainder of the study interval. Restriction of the higher nitrate nitrogen values to the spring measurements suggests fertilizer as a probable source.

As expected, water temperature showed an increasing trend during the spring and early summer months. From the low of 19°C on 4/28, water temperature in Catoma Creek (Fig. 5) gradually climbed to a high of 29°C recorded on 7/7 and 7/14. Increased rainfall and lower air temperatures produced somewhat lower temperatures at later dates.

# Water Quality of Catoma Creek

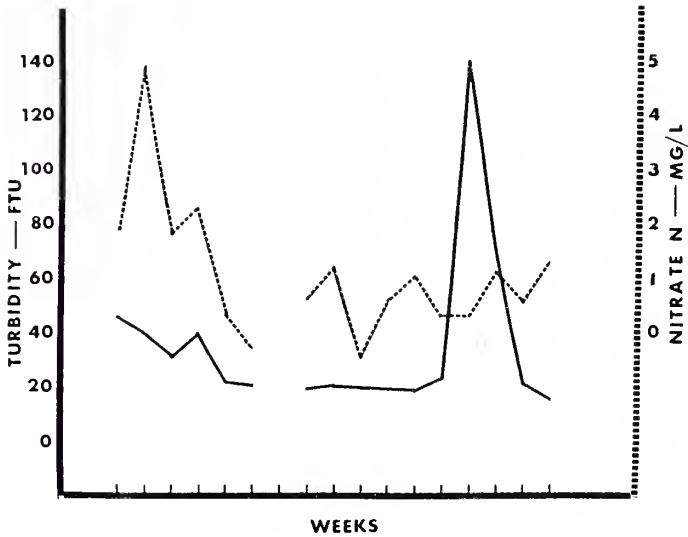


Figure 4. Turbidity in formazin turbidity units and nitrate nitrogen in milligrams per liter are graphed for Catoma Creek at weekly intervals beginning 4/28 and ending 8/18. No data were recorded on 6/9.

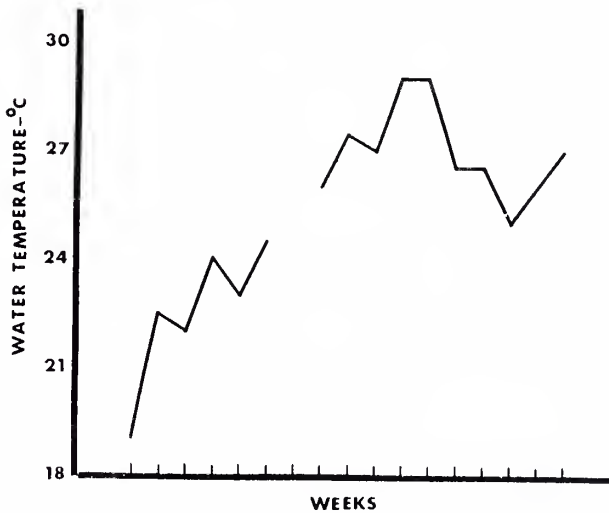


Figure 5. Water temperature is recorded in degrees Celsius for Catoma Creek at weekly intervals between 4/28 and 8/18. No temperature was taken on 6/9.

Coliform and fecal coliform bacteria were detected at all dates on which tests were conducted. Beginning on 7/21, quantitative tests involving serial dilutions were performed to determine densities of coliform bacteria. Quantitative tests for fecal coliforms were begun on 7/28. Table 2 presents the coliform and fecal coliform data for Catoma Creek. Although it is not certain, it seems likely that the coliform density of 1609 per 100 ml represented an increase over densities in the preceding weeks. Prior to 7/21 the first appreciable rains in weeks had slightly increased the flow. On 7/28, the date of greatly increased flow, the total coliform count increased greatly. The samples were not diluted sufficiently to determine the density, but it was established that both coliform and fecal coliform densities were greater than 16,090 per 100 ml. Total and fecal coliform densities declined to 8000 and 5000 per 100 ml respectively on 8/4, a period of decreasing, but still high, flow. By 8/11, flow was considerably reduced and bacterial counts had diminished greatly to well under 300 per 100 ml. The great increase in fecal coliforms on 7/28 probably was produced by entry of runoff from storms. Runoff from storms is collected in open channels, some of which discharge into Catoma Creek. In the past another possible source of fecal coliforms would have been the Catoma Creek Sewage Treatment Plant which had a discharge slightly upstream from the sampling site. However, the plant ceased discharging there on May 21, 1977, well before the densities were measured. The total coliform levels found in Catoma Creek were below those typically encountered in highly polluted streams except on 7/28 and 8/4. However, fecal coliforms and total coliforms at these times were sufficiently high to render Catoma Creek unfit for most uses. The Alabama Water Improvement Commission (AWIC, 1973a) places Catoma Creek in its lowest water quality class, i.e., Fish and Wildlife as a Goal. Waters in this category are not currently suitable for use as a public water supply, for swimming, or for fish and wildlife propagation. The classification, Fish and Wildlife as a Goal, implies that improvement of water quality is desired, but the results of the present study indicate that this goal has not yet been attained (AWIC, 1973b). To qualify for use as a public water supply, water must have neither more than 4000 coliforms per 100 ml in any sample nor a monthly geometric mean greater than 2000 per 100 ml. To qualify for the Fish and Wildlife class, water must contain no more than 2000/100 ml and its monthly geometric mean must be below 1000/100 ml. Requirements for swimming water are still more stringent. The bacterial densities greatly exceeded acceptable levels on 2 of 5 dates (Table 2). Although conditions may be improved by the closure of the Catoma Creek Sewage Treatment Plant, the goal of improving Catoma Creek's water sufficiently for fish and wildlife usage has yet to be attained. A substantial and unabated pollutant load appears to be contributed by drainage of urban stormwater.

It is apparent that Catoma Creek is a polluted stream. Its water quality is not static, but constantly changes due to variations in weather, seasons, effluents and other inputs. Stream conditions in Catoma Creek are strongly influenced by flow. Several of the variables measured in the current study seemed to respond to changes in flow, including phosphates, apparent color, turbidity, total and fecal coliform densities, and probably dissolved solids. Further monitoring of Catoma Creek would be necessary to detect seasonal fluctuations of the variables measured. A better understanding of stream conditions could be obtained



## Water Quality of Catoma Creek

Table 2. Total and fecal coliform data for Catoma Creek.

Date	Coliform	Fecal Coliform
4/28	✓	-
5/5	✓	✓
5/12	✓	✓
5/19	✓	✓
5/26	✓	✓
6/2	✓	✓
6/16	-	-
6/23	✓	✓
6/30	✓	✓
7/7	✓	✓
7/14	✓	-
7/21	1,609	-
7/28	>16,090	>16,090
8/4	8,000	5,000
8/11	270	220
8/18	542	34

✓ Bacteria present.

- Test not done.

Numerical data are bacteria per 100 ml.

by including measurements of dissolved oxygen concentration and biochemical oxygen demand. Data on composition of the biotic community would also be instructive. It should also be noted that the present study reports data from a single sampling location on Catoma Creek. From its headwaters to its junction with the Alabama River, Catoma Creek presumably shows several variations in important aspects of water quality.

### ACKNOWLEDGEMENTS

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CHINESE ARCHAEOLOGY AND THE CREATION  
OF "PEOPLES' HISTORY"<sup>1</sup>

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*Abstract.* Throughout their long history the Chinese have viewed their past cultural achievements as both unique and superior. This love for things past was briefly threatened by the upheaval of the Great Proletarian Cultural Revolution. Wall posters called for the smashing of relics associated with the traditional culture of the emperors. In time this threat to China's priceless archaeological heritage gave way to a desire to use archaeology to create an ideologically useful "Peoples' History."

This paper deals with the attempt of the Chinese to create "Peoples' History" by the political use of socio-archaeology. "Peoples' History" enhances the cultural contributions of the masses at the expense of China's imperial elites. Scholars interested in ethnohistorical reconstructions of Chinese Culture are informed of the tendency of "Peoples' History" to make objective interpretations of Chinese archaeological and historical data difficult.

INTRODUCTION

Due to a grant from the National Committee on U.S.-China Relations, I was one of the thousands of Americans who experienced that aesthetic banquet known officially as "The Exhibition of Archaeological Finds of the Peoples' Republic of China." The Exhibition generated a milieu of good will that should serve the cause of U.S.-Chinese Relations for many years to come.

Currently archaeology has re-emerged as an important cultural link between China and the West. The new discoveries made since the Communist victory in 1949 have greatly expanded our knowledge of Chinese cultural history. Recent fossil evidence of *Ramapithecus* in Yunnan, *Homo Sapiens neanderthalensis* in Hupei, and the now famous Lan-tien Man of Shensi Province has placed China in the center of paleontological activity. The Chinese, no strangers to cultural longevity, can be justly proud of China's place in Asia's pre-history. The several thousand neolithic sites now recorded are rich with information about the origins of agriculture in China and the changing ecosystems of ancient Chinese populations.

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<sup>1</sup>Manuscript received 16 November 1977; accepted 31 January 1978.

## SOCIO-ARCHAEOLOGY AND HISTORY IN CHINA

In China where, according to Judith M. Treistman: "historical consciousness has developed more intensely than anywhere else in the world,"<sup>2</sup> archaeology is still a young science. Chinese history has been written since the middle of the second millennium B.C., while scientific archaeology in China only started about fifty years ago.

In fairness to the Chinese, the incorporation of archaeological data in the Chinese historical expression known as "antiquarianism" preceded the coming of scientific archaeology by about 2,000 years. The second century B.C. court historian Ssu-ma Chien "wrote a history of China. . . . which was in part, based upon archaeological research,"<sup>3</sup> though not true archaeology, antiquarianism did produce a great deal of data on the discovery and locations of many ancient artifacts.

Of course the dynastic histories of the ancient Chinese do not constitute the ethnohistorical reconstructions required by modern scholars. To supplement traditional Chinese history, archaeologists are engaged in socio-archaeology, i.e. the use of archaeological data to reconstruct ancient socio-cultural systems.

Scientific archaeology started in the early 1920's with the discovery of the Yangshao neolithic culture and the paleolithic remains of Peking Man. In 1928 the Chinese government founded *Academia Sinica* or the Chinese Academy of Sciences. Chinese archaeologists began to apply archaeological verification to many long standing questions in Chinese history. Progress in archaeology continued until 1937 when the invasion of China by the Japanese suspended all work. The post war struggle between the Communists and the Nationalists further retarded archaeology, but the end of hostilities on the mainland in 1949 was closely followed by a resumption of archaeological activity.

## POLITICAL ARCHAEOLOGY

The government of the Peoples' Republic of China shows an active interest in archaeology but not totally from a scientific perspective. Archaeology in China is political, a revolutionary enterprise. The Chinese government supports archaeology because it serves the "continuing revolution." Just how archaeology serves the political interests of the Chinese government became clear during the Great Proletarian Cultural Revolution of the late sixties. One theme of the Cultural Revolution that was potentially dangerous to archaeology was the demand of some propagandists that China turn violently away from the past. "When the Red Guards began to rampage through China in 1966, the country almost completely barricaded itself against the outside world. The Red

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<sup>2</sup> Judith M. Treistman, "Problems in Contemporary Asian Archaeology," *The Journal of Asian Studies*, Vol. XXIX, No. 2 (Association for Asian Studies, 1970), p. 369.

<sup>3</sup> Jason W. Smith, *Foundations of Archaeology* (Beverly Hills, Glencoe Press, 1976), p. 26.

Guards developed into a self-generating tidal wave of youthful political fanaticism, unadulterated and undirected, such as had never been seen before. They shouted of smashing every relic of traditional culture associated with the old emperors and their concubines, and everything tainted by the West."<sup>4</sup> In the West there was great concern that irreparable damage was being done to China's archaeological treasures. For six years, from 1966 to 1972, China produced no archaeological publications and this was taken as an ominous sign.

However, we now know that a subtle ideological shift took place during those violent years that actually benefited archaeology. Describing this shift William Watson states: "The anger about the imperial past had spilled over into threatening demonstrations against some imperial sites and treasures, but it had steadied and been channeled into a more constructive attitude: that the treasures of the past demonstrated the ageless skill and genius of the working class who made them, not the genius of the emperors who enjoyed them."<sup>5</sup>

Thus archaeology was incorporated in the ideological thrust of the Cultural Revolution. The past was important because it served the present. As John Hay observed: "It is plain that China's many trained archaeologists have been given ample doctrinal justification for their work: every archaeological publication is prefaced with the words of Chairman Mao, often to the effect that the past must not be forgotten but must serve the present."<sup>6</sup>

### SOCIO-ARCHAEOLOGY AND IDEOLOGY

The Chinese are interested in using archaeology to reconstruct ancient Chinese socio-cultural and political patterns. In his article "Socio-Archaeology" for *Current Anthropology*, Gutorm Gjessing states: "Socio-political archaeology is far from a European monopoly. Chang (1967: 53-54) discusses a site at Ching Chou, Honan, China, which a study of the complex pattern of dwellings and burials has shown to have been a major political and ceremonial center with quarters for various social classes."<sup>7</sup>

Chinese archaeologists may engage in socio-archaeology but their analysis of recovered data must serve the political interests of the Chinese people. The socio-cultural and political patterns re-discovered must reflect the class struggle as it manifested itself in ancient China. All socio-cultural and political reconstructions must conform to present revolutionary ideology, "Like many other important archaeological

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<sup>4</sup> John Hay, *Ancient China* (New York, Henry Z. Walck, 1973), p. 12.

<sup>5</sup> William Watson, *Ancient China: The Discoveries of Post Liberation Archaeology* (New York Graphic Society, 1974), p. 9.

<sup>6</sup> John Hay, *Ancient China* (New York, Henry Z. Walck, 1973).

<sup>7</sup> Gutorm Gjessing, "Socio-Archaeology," *Current Anthropology*, Vol. 16, No. 3 (University of Chicago Press, September, 1975), p. 329.

undertakings in China, the excavation of the Han tombs at Manching not only aids the study of ancient Chinese society but also provide vivid data for popular education in ideology, politics and class struggle."<sup>8</sup>

In addition to the politicalization of archaeology and in keeping with "the technique known as 'the mass line,'"<sup>9</sup> archaeology in China is to be an enterprise of the people. The preservation of the cultural relics is the responsibility of the Chinese people. In an essay entitled: "The Masses Support Archaeological Work," Chinese archaeologists Chang Li-chuan and Lin Yu-ching stated: "Quite a few of the numerous cultural relics brought to light during the Great Proletarian Cultural Revolution have been the contributions made to the state by workers, peasants and People's Liberation Army men. Many inspiring stories have been told of their activities in supporting archaeological work."<sup>10</sup> The Chinese people are expected to report any discoveries and freely volunteer their labor in subsequent excavations.

Chinese archaeological literature is careful to note the contributions made by non-archaeologists. In some instances the names of individual workers, peasants or soldiers are singled out for meritorious mention. Chinese Communist ideology demands that: "the masses must take themselves masters of culture and science."<sup>11</sup> Archaeology is not to be carried on by or for "elites." The union of the archaeologists and the people is consistent with the Marxist ideological theme that abolishes the distinction between mental and manual work.<sup>12</sup> The mental contributions of the archaeologists and the manual work of the masses is of equal merit in the dynamics of the "mass line."

#### "PEOPLES' HISTORY"

According to Chairman Mao: "In China education has always been the exclusive preserve of the landlords and the peasants had no access to it. The landlords' culture is created by the peasants for its source is the peasants' sweat and blood."<sup>13</sup> With each new discovery Chinese

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<sup>8</sup> *New Archaeological Finds in China: Discoveries During the Cultural Revolution* (Peking, Foreign Language Press, 1974), p. 20.

<sup>9</sup> C. Martin Wilbur, "China and the Skeptical Eye," *The Journal of Asian Studies*, Vol. XXXI, No. 4 (Association for Asian Studies, August 1972), p. 765.

<sup>10</sup> *New Archaeological Finds in China*, p. 47. Chang Li-chuan and Lin Yu-ching, "The Masses Support Archaeological Work."

<sup>11</sup> Maurice Meisner, "Utopian Goals and Ascetic Values in Chinese Communist Ideology," *The Journal of Asian Studies*, Vol. XXVIII, quoting a rallying cry frequently heard during the Great Leap Forward.

<sup>12</sup> Meisner, p. 103.

<sup>13</sup> Meisner, p. 104.

archaeological publications are careful to include a peoples' historical interpretation. Since culture is created by the peasants, then their story constitutes, for Chairman Mao, China's true cultural history i.e. "Peoples' History." Archaeology's mission is to support the creation of a "Peoples' History": "Tempered in the Cultural Revolution and advancing along the revolutionary path pointed out by Chairman Mao, Chinese archaeologists are determined to make their work serve proletarian politics better by providing rich evidence for historical materialism."<sup>14</sup>

To peruse examples of the new "Peoples' History" all one needs to do is review some recent Chinese archaeological publications. An introduction to a booklet on the Yunkang Caves includes this passage: "The Yunkang cave temples spread the message of religious superstition which helped to bolster the feudal regimes. However, as great works of sculpture, they occupy an important position in the history of Chinese art. They reflect the superb creative talents of the laboring people of ancient China and remain priceless relics for critical study and assimilation."<sup>15</sup>

In a treatment of the Han Tombs at Manching archaeologist Ku Yen-wen observed: "The discovery of the two tombs reveals the feudal rulers' crimes of cruelly exploiting the people in their lifetime and dreaming of continuing to do so in another world. . . . Every cultural find of the Han Tombs bears the sweat and blood of the working people."<sup>16</sup> "Peoples' History" is designed to present history in such a way as to build revolutionary fervor and give the masses a sense of their own cultural accomplishments. A revolutionary view of Ancient Chinese History meets Mao's dictum "Make the past serve the present."<sup>17</sup>

#### PEOPLES' HISTORY AND CHINA'S FUTURE

While a creation of "Peoples' History" may seem beneficial to the contemporary Chinese, the long range interests of the Chinese people might be better served by the development of a less political and ethnocentric historical consciousness. In the past, Chinese cultural and historical consciousness isolated China from objective reality, and the "Central Kingdom" suffered internal disorder and foreign incursions. Scientific investigations, designed to support given political theoretical propositions, will not, at all times, serve objective reality. A situation of "Peoples' History" versus science is inevitable. The present political reality demands in China, if the political need arises,

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<sup>14</sup> *New Archaeological Finds in China*, p. 1. Hsia Nai, "Archaeological Work During the Cultural Revolution."

<sup>15</sup> *The Yunkang Caves* (Peking, The Institute for the Preservation of Yunkang Antiquities, Shensi. Published by Wen Wu Press, 1973), p. 1.

<sup>16</sup> *New Archaeological Finds in China*, p. 15-18. Ku Yen-wen, "Han Tombs at Manching."

<sup>17</sup> Meisner, p. 29.



the subordination of objective reality. Chinese archaeology will still retain the excellence achieved in excavation techniques and laboratory reconstruction but the theoretical flexibility necessary for socio-archaeology will elude the Chinese.

The Western scholars, who remain hopeful for the opportunity of cross-cultural research in China, must keep in mind the Chinese view that: "Men still make history and the Chinese will make their history as they interpret their own situation in the light of their own ideas."<sup>18</sup>

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PREVALENCE OF LEPTOSPIROSIS AND TULAREMIA IN  
ALABAMA FERAL AND FREE-RANGING DOGS<sup>1</sup>

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*Abstract.* Forty uncollared mongrel dogs suspected of being feral were live-trapped in Alabama during 1970-71. Ten were caught near Childersburg and 30 near Auburn. Biotelemetry equipment was used to differentiate feral from free-ranging domestic dogs. Twelve of the dogs were determined to be feral. Sera from 20 of the trapped dogs were collected and tested for leptospiral and tularemia antibodies using microscopic and macroscopic agglutination tests, respectively. No leptospiral or tularemia antibodies were demonstrated in the eight feral dogs tested. Five free-ranging domestic dogs tested from the Childersburg area had tularemia antibodies. None of seven free-ranging domestic dogs tested from the Auburn area had tularemia antibodies. No tests were made for active disease, only prior experience. Leptospiral antibodies were not found in any of the five Childersburg domestic dogs or the seven Auburn domestic dogs. The low incidence of leptospirosis and tularemia found in dogs during this study contrasted with the relatively high rates of incidence published by other investigators.

INTRODUCTION

Feral dogs (dogs that have reverted to a wild existence) have been reported from all of the continental United States (McKnight 1964) and several papers have been published concerning leptospirosis and tularemia in a limited number of 'feral' dogs (Gorman et al. 1962, Hays and Foster 1966, McKeever et al. 1958, McKeever et al. 1958a).

The dogs studied by all of these authors were collected by trapping or shooting. No mention was made as to the criteria used to determine if the dogs were truly feral, or if they were simply free-ranging pets. During the initial stages of a study on the ecology of feral dogs in Alabama we discovered that feral dogs were not as abundant, or as easily identified, as most local residents believed. This paper presents data concerning the incidence of tularemia and leptospirosis in dogs we investigated and includes the method we used to differentiate feral dogs.

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## Leptospirosis and Tularemia

Access to study areas was obtained through the Alabama Cooperative Wildlife Research Unit at Auburn University, and the Alabama Army Ammunition Plant at Childersburg. Staff of the Veterinary Diagnostic Laboratory, Auburn University, assisted in the serological tests for leptospirosis.

### MATERIALS AND METHODS

Feral dogs were studied on the 9,000 acre Saugahatchee research area, located in east-central Alabama on the outskirts of the city of Auburn, and the 4,000 acre Childersburg research area, near the city of Childersburg in central Alabama. Both areas are located in the Alabama Piedmont, and are forested with shortleaf pine (*Pinus echinata*) and loblolly pine (*Pinus taeda*) interspersed with several species of oak (*Quercus* spp.) and hickory (*Carya* spp.). Several small rural farms are on the Saugahatchee area. The Childersburg area is supervised by the Alabama Army Ammunition Plant, and human access is restricted to maintenance personnel.

Tomahawk No. 110 live traps baited with waste raw meat products were used to capture dogs. Traps were placed along logging roads in forested areas, usually a mile or more from rural homes. Trapping was conducted on the Saugahatchee area from May, 1970 through June, 1971, and on the Childersburg area from October, 1970 through March, 1971.

Dogs which were aggressive toward the investigators while in traps were assumed to be feral. Biotelemetry equipment was used to determine if the "suspect" dogs ever associated with humans. Dogs were equipped with 150-151 MHz radio-transmitter collars of a design similar to that described by Cochran (1967). A portable receiver, equipped with a 3-element yagi antenna, was used in radio-locating the dogs by triangulation (Heezen and Tester 1967).

Dogs were radio-located approximately four times per week, and were also tracked during several diel (24-hour) periods. Any dog that associated with humans was eliminated from our list of feral dogs.

Blood samples were taken from dogs suspected to be feral at time of capture, and sera were collected for analyses. The macroscopic tube agglutination test was used to determine the presence of *Pasteurella tularensis* antibodies. Titers of 1:80 or higher and showing at least 50 percent agglutination were considered positive. Sera were also tested for *Brucella abortus* antibodies which might have interfered with the tularemia agglutination test.

The microscopic agglutination test was used to detect leptospiral antibodies. Live antigens used in the test were *Leptospira pomona*, *L. canicola*, and *L. icterohaemorrhagiae*. A titer of 1:100 or higher with 50 percent clearance of antigen was considered positive.

### RESULTS

A total of 40 uncollared mongrel dogs was trapped on the two study areas. Ten were caught near Childersburg and 30 near Auburn. Fifteen

showed obvious signs of domestication (i.e., tail wagging and/or friendly disposition). These dogs were immediately released, and only two were seen on the research area again. Twenty-five dogs showed varying degrees of aggressive behavior while in traps. Radio-tracking proved 12 of these aggressive dogs were feral. Ten were members of three separate packs, and two were solitary. One solitary feral dog resided on the Childersburg area. The other solitary dog, and all of the packs, lived on the Saugahatchee study area, near Auburn.

Visual observations and radio-tracking indicated that the remaining aggressive dogs were not feral. Many of these dogs appeared to spend much of their time roaming, while occasionally returning to occupied dwellings for food and shelter.

Serological tests for leptospiral and tularemia antibodies in eight feral dogs were negative. Sera from 12 aggressive free-ranging dogs were also tested to determine if a difference existed between domestic and feral dog populations. All free-ranging dogs were negative for leptospiral antibodies, and only one (from the Childersburg area) was positive for tularemia antibodies.

#### DISCUSSION

In addition to the 40 dogs trapped, we observed 66 others along rural roads and in forested areas on the two study areas at least 1 mile from any human habitation. Most of these dogs were uncollared mongrels which fled when approached. We had previously observed many of these dogs associated with rural homes. Most of the dogs we trapped or observed in rural areas would have been subject to collection for disease surveys described by previous investigators (Gorman et al. 1962, Hays and Foster 1966, McKeever et al. 1958, McKeever et al. 1958a). Since our radio-tracking and visual observations indicated only a small percentage of the dogs roaming in rural areas was feral, it seems likely that the methods previous investigators used to designate feral dogs were inaccurate. This means that previous reports of disease rates in 'feral' animals have little foundation.

The near-absence of tularemia antibodies in feral and domestic dogs we examined was unexpected on the basis of previous reports. Serological evidence for tularemia in wild mammals, including one 'wild' dog, has been reported from eastern Alabama (Hays and Foster 1966), where the Saugahatchee area is located. Calhoun et al. (1956) found 32 percent of the tame dogs they examined from rural Arkansas areas were positive for tularemia antibodies.

The absence of leptospiral antibodies in dogs we examined also differed from published information. Alexander et al. (1957) reported 34.7 percent of the tame dogs they examined from Alabama were positive for leptospiral antibodies.

Differences between our results and other published data may be due to the failure of some investigators to publish negative results from disease prevalence surveys which, in turn, causes a false impression

## Leptospirosis and Tularemia

that a significant proportion of the animals in all areas are disease carriers. Also, our sample size is small enough to be misleading.

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## Notes



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## ABSTRACTS

Papers presented at the 55th Annual Meeting  
Troy State University  
Montgomery Civic Center  
Montgomery, Alabama  
April 6-9, 1978

### BIOLOGICAL SCIENCES

#### SOME AQUATIC HYPHOMYCETES FROM ALABAMA

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Imported organic material, mostly leaves, is of paramount significance in the food chain in streams and rivers. It has been estimated that this material contributes well over half of the energy budget of fresh water communities. Access by animals to much of this material depends on the interaction of micro-organisms, particularly fungi. The fungi function as agents of degradation and by increasing their own biomass provide a source of readily digestible food material for many animals. Although aquatic hyphomycetes have been described from several parts of the world no adequate documentation of their occurrence in the southeastern United States is available except for records of a few from Georgia and Tennessee.

Our studies indicate the presence of an extensive hyphomycete flora in fast-flowing Lee County streams. Twenty-three previously known species have been collected and eleven isolated in pure cultures. A number of undescribed taxa have been discovered including a species of *Tricelophorus* Ingold for which we propose to establish the name *T. multiseptata*. Many of these fungi have not previously been reported as occurring in North America.

Investigations of seasonal occurrence by monthly examination of naturally introduced leaves and experimentally added leaf discs indicate minor differences in populations at various times of the year. Studies of colonization of leaf discs from seven different native tree species show little host preference among the hyphomycetes.

## Abstracts

### SOME MYCOPARASITIC HYPHOMYCETES

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A study of mycoparasitic hyphomycetes growing on members of the Agaricales and Aphyllophorales in Alabama has been indicated. Preliminary observations indicate the presence of numerous species as could be expected given the climatic conditions and the occurrence of a diverse flora of higher fungi to serve as hosts.

To date fifteen species have been identified and isolated in pure culture. Of these several are new records for North America and two are undescribed taxa. Among the most common species are *Mycogone rosea* Link, *Sepedonium chrysospermum* Link and the hyphomycete state of *Hypomyces tulasneanus* Plowright. It is proposed to establish the names *Sibirina alabamensis* and *Cladobotryum clavatum*, respectively, for the new species.

Host-parasite relationships in pure culture are being investigated as well as field studies to determine host specificities of various taxa.

### PISTIL DEVELOPMENT AS RELATED TO FLORAL ABSCISSION IN SOYBEAN, *GLYCINE MAX* (L.) MERR.

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Field studies were performed during the summer of 1976 and 1977 on terminal racemes of 'Bragg' soybeans [*Glycine max* (L.) Merr.] to gain further information about flower and pod abscission of soybeans growing under typical field conditions. In 1977 a mean number of 16.2 potential pods was formed per raceme. However, only a mean number of 1.17 mature pods per raceme was present at the end of the growing season. Over 90 percent of the potential pods abscised mostly as anthesis flowers and young pods. More than 60 percent of these abscissions occurred during a 14-day period when flowering reached its peak in mid-August. Most of the abscissions occurred in the distal portions, although in 25 percent of the racemes, all potential pods abscised. In those racemes with mature pods, 83 percent of the pods were located in the first 7 proximal positions. Neither excising the distal ends of developing racemes containing a mean number of 6 floral buds each, nor treating the distal ends of racemes with two different growth regulators alone or in combination, affected the total number of abscissions.

Previous reports indicate that abscised flowers predominantly contain proembryos of 4-8 cells. Comparative histological observations were made of abscised and nonabscised flowers and young pods collected from field grown plants to establish the precise stage of development when most abscissions occurred. No unfertilized ovules were observed.

## Abstracts

More than 80 percent of the ovules examined in paraffin sections of abscised flowers contained proembryos of 4-8 cells surrounded by a conspicuous acellular endosperm, thus indicating that double fertilization had occurred. However, observations of ovules collected over a wider range of development based on embryo sac and nectary development revealed that about 55 percent of the embryo sacs contained stages of development at double fertilization or immediately thereafter. This stage is characterized by heavy deposits of starch packets within the embryo sacs, most of which disappear by the 2-celled stage and are absent at the 4-celled stage. Additional cyto-chemical observations of flower pedicels, ovary walls, and ovules of both abscised and nonabscised flowers indicated no conspicuous qualitative differences in the levels of total carbohydrates, protein, RNA, DNA, or ergastic substances.

### SOME GROWTH CHARACTERISTICS OF TWO PLANT PATHOGENIC SPIROPLASMAS

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Spiroplasmas are cell wall-free prokaryotes with a helical morphology. Originally proposed in 1971 as a trivial term for the organism associated with corn stunt disease, spiroplasma has been adopted as the genus name for the causal agent of citrus stubborn disease, *Spiroplasma citri*. The spiroplasmas are placed in the newly-erected family Spiroplasmataceae of the class Mollicutes. In recent years, spiroplasmas have been associated with several plant diseases and spiroplasma etiology has been established for a few of them.

Since morphological similarities between *S. citri* and the corn stunt spiroplasma (CSS) suggest the two organisms might be closely related, some of their *in vitro* growth characteristics were compared. In a simple medium developed for this study, both spiroplasmas showed a characteristic sigmoid pattern of growth, but *S. citri* grew more rapidly than CSS as determined by: acid and alkaline color reactions in the medium, population generation times, and rates of growth and death. *S. citri* reached maximum titer of  $10^9$  cells/ml in 3 days; maximum titer for CSS was  $10^8$  cells/ml in 4-5 days. These results indicate that *S. citri* and CSS differ in some growth characteristics; however, these differences are not considered sufficient to designate CSS as a new species.

### THE POTENTIAL SIGNIFICANCE OF COLLEMBOLA-MICROFLORA INTERACTIONS IN THE RHIZOSPHERE OF COTTON

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Collembola (Apterygota) of the genera *Proisotoma* and *Onychiurus* are more abundant in the rhizosphere of *Gossypium hirsutum* L. than in

## Abstracts

root-free soil in Alabama fields. In laboratory tests it was determined that these minute insects are mycophagous, and they rapidly destroyed young cultures of both saprophytic and plant-pathogenic fungi. They were shown to transport bacteria and fungal spores on and in their bodies and to initiate microfloral colonization of cotton-seedling rhizosphere; in drying soil the insects migrate to the root surface where moisture is available. Environmentally controlled experiments were conducted in large glass tubes (20 × 150 mm) of sterilized or nonsterilized sandy loam artificially infested with collembolans and the cotton pathogen, *Rhizoctonia solani* Kuhn. Disinfected, pre-germinated seed (Stoneville 213) were then planted. Results showed a significant reduction in the disease-injury index. Greenhouse tests in pots of nonsterilized field soil, either naturally infested with *R. solani* or supplemented with chopped-oat-substrate inoculum, revealed further a biological control benefit attributed to added collembolans. In all cases, the protective role of the insects was closely dependent upon their numbers in relation to inoculum density of the pathogen. Supplementary populations of 500-800 collembolans were required to increase seedling emergence and reduce disease severity in nonsterilized soil with *Rhizoctonia* inoculum supplements of 0.3-0.5 g infested oats/kg soil (dry wt). This study suggests the logic of considering the role of mycophagous microarthropods in ecological investigations relating to rhizosphere and root disease.

### ANTIBACTERIAL ACTIVITY OF 3-(1,2-EPOXYPROPYL)-5,6-DIHYDRO-5-HYDROXY-6-METHYLPYRAN-2-ONE

Joy Wells, Lynn Kaganich, Jack H. Moore, and Thomas P. Murray  
Department of Biology  
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The lactone was produced by *Aspergillus ochraceus* grown on a semi-synthetic medium. The antibiotic activity was minimal as determined by the filter-disc method using the vegetative cells of several Gram positive and Gram negative bacteria and endospores of *Bacillus cereus*.

### GROWTH IN RELATION TO FOOD CONSUMPTION IN A SNAKE (*ELAPHE GUTTATA GUTTATA*)

Martin Nowak and Ken Marion  
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Hatchling corn snakes (*Elaphe guttata guttata*) were fed weighed amounts of food (mice), and their growth was monitored for 570 days. Snout-vent length, body weight, feces weight, and shed skin weight and frequency were recorded at various intervals during the study. Snout-vent length showed a basically linear relationship with time, though some decrease in length increase rate was evident near the termination of the experiment. Body weight was non-linear with time, exponential

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growth being the best fit. Snout-vent length showed a non-linear relationship with the weight of food consumed, parabolic growth being the best fit. There was a linear relationship between body weight and weight of food consumed. The decrease in snout-vent length increase rate is discussed in terms of volumetric-length relationships and the attainment of sexual maturity.

### FOOD HABITS OF THE FENCE LIZARD (*SCELOPORUS UNDULATUS*)

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Stomach content analysis of the fence lizard, *Sceloporus undulatus*, revealed that the invertebrate orders Hymenoptera, Coleoptera, Arachnida, and Lepidoptera comprised the most common food items. Of all items ingested, 53.1% were hymenopterans, 15.6% coleopterans, 8.1% arachnids, and 5.0% lepidopterans. The total nutritional role of coleopterans and lepidopterans is further increased, as they constituted the largest mean lengths of food items ingested.

Stomach content volumes and number of food items/lizard were significantly larger ( $p < 0.05$ ) for females than males. In both sexes, significantly larger food items were ingested in fall as compared to spring. There was a trend toward increased food intake in fall as compared to spring. These sexual and seasonal differences in results are discussed in terms of sexual size dimorphism, seasonal food availability, and the need for the female to secure high levels of nutrition for reproductive processes.

Supported by a grant from the Graduate School, University of Alabama in Birmingham.

### GENETIC SOURCES OF WING LENGTH VARIATION IN *DROSOPHILA MELANOGASTER*

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Wing length variances in inbred and outcrossed strains of both *wildtype* and *miniature* winged *Drosophila melanogaster* were compared for significant differences. Each sex of the four fly types (inbred *wildtype* and *miniature* and outcrossed, or polygenically variable, *wildtype* and *miniature*) were analyzed separately. The wing length variances of the resulting eight fly types, each replicated three times, were subjected to an analysis of variance in a  $2^3$  factorial design, after transforming the sample variances into the more normally distributed statistic, natural log of the variance. Tests of significance were performed



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on the three main effects (sex; qualitative genotype, represented by *wildtype* or *miniature*; and polygenic constitution, that is inbred or outcrossed) and all 2- and 3-factor interactions.

All three main effects were found to be highly significant in their contributions to the overall phenotypic variation in wing length observed in the experiment. Females, for example, showed more variation in wing length than males. This observation is best explained in terms of a dosage effect, attributable to the extra set of polygenes on the second X-chromosome not found in males. Furthermore, the polygenically variable outcrossed strains displayed much greater variation in wing length than their inbred counterparts due to the increased genetic variability in these flies. Also, the *wildtype* wing lengths showed more variation than *miniature* wing lengths.

The only significant interaction was that between qualitative genotype and polygenic constitution. While both *wildtype* and *miniature* flies showed the same low wing length variance when inbred, the *wildtype* strains showed a greater increase in variation when outcrossed than did the *miniature* strains. Two explanations are, at present, equally plausible. It is possible that in the presence of a homozygous *miniature* genotype, the expression of the variable polygenes is restricted by some means, whereas in the *wildtype* strains no such inhibition of polygenic expression occurs. The alternative explanation, however, is that the outcrossed *miniature* strain developed for this experiment simply had less polygenic variation in it than the outcrossed *wildtype* strain. An experiment is presently underway to distinguish between these two possibilities.

### AUDIO-TUTORIAL BIOLOGY AT AUBURN UNIVERSITY--A SEVEN YEAR EXPERIMENT

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An audio-tutorial mode of instruction for a freshmen-level biology course was implemented in 1971. Subsequent revisions and modifications of course content, audio-visuals, and supplementary materials have been made repeatedly in response to recommendations and evaluations from faculty and students.

Experimental evaluations of the A-T instructional mode has been attempted several times with the following results: (1) Optional retesting on only the first unit test was more effective than on all three unit tests; (2) The option of incomplete grades had a negative influence on student achievement; (3) A comparison of A-T and conventional lecture-lab instructional modes resulted in significantly higher scores by A-T groups on tests for both immediate achievement and long-term retention; (4) Frequent and repeatable testing promoted significantly higher mean cumulative scores than did conventional testing; however, it resulted in no increase in achievement nor retention as measured by comprehensive

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final tests; and (5) Student achievement, as reflected in percentage distribution of course grades, was consistently higher at A and B levels with A-T instruction.

### STUDENT SELECTION BETWEEN TRADITIONAL AND AUDIO-TUTORIAL INSTRUCTIONAL MODES IN BIOLOGY AT AUBURN UNIVERSITY

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The audio-tutorial mode of instruction appears to offer distinct advantages for certain students. The method is disliked by many students, yet data from years past show significantly higher test averages and grade distribution in classes taught by A-T. We have recently offered students a choice at registration between conventional lecture-lab and A-T sections. Approximately half chose each format. We had expected the students choosing A-T to score higher, as had students arbitrarily assigned to A-T classes. This did not occur however. The difference on identical finals disappeared between students given a free choice of the two instructional modes.

### TOXIGENICITY OF FUNGI ISOLATED FROM GRAIN SORGHUM

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Fungi were isolated from 8 samples of freshly harvested grain sorghum in 1976 and another sample of 1976 crop stored on a farm for 8-9 months. The nineteen species of fungi were isolated and identified. Species of *Aspergillus*, *Penicillium*, *Fusarium*, and *Curvularia* dominated the mycoflora. Eight of these 19 species were bioassayed for toxicity to brine shrimp. *Epicoccum purpurascens* and *P. herquei* were highly toxic; *C. lunata*, *C. clavata*, and *Mucor mucedo* were slightly to moderately toxic; and *A. flavus*, *A. fumigatus*, and *P. raistrickii* were non-toxic. *C. clavata*, *A. flavus*, *P. raistrickii*, and *M. mucedo* were highly toxic in the chick embryo bioassay.

### ADDITIONAL NOTEWORTHY WEEDY PLANTS OF THE MOBILE REGION

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The weed Flora of the Mobile Region has apparently changed somewhat since the turn of the century. Most of the numerous "Ballast" weeds

reported by Charles Mohr in his "Plant Life of Alabama" (1901) have failed to become established and to spread while many of our common present-day weeds were not observed by Mohr although he resided in Mobile over 40 years. Many of those recently introduced weeds were not even reported by Small for our area in his "Manual of the Southeastern Flora" (1933). Examples of such recently introduced plants are *Allium inodorum* (Liliaceae), native of Africa; *Chenopodium pumilio* (Chenopodiaceae) of Australia; *Eragrostis amabilis* (Poaceae), adventive in warmer parts of the Old World; *Hedeoma hispida* (Lamiaceae), native in the Great Plains; *Imperata brasiliensis*, a tropical American grass; *Koeleria phleoides*, an European grass; *Leptochloa uninervia*, a grass of Tropical America; *Nicotiana longiflora* (Solanaceae), of South America; *Parietaria praetermissa* (Urticaceae); *Plantago hookeriana* var. *nuda*, native in the Southwest; *Petunia parviflora* (Solanaceae) and *Scoparia dulcis* (Scrophulariaceae), both native of Tropical America.

## INDIRECT MEASUREMENT OF $Q_{10}$ IN CRICKETS

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Male crickets, *Acheta domestica*, were labeled with  $^{65}\text{Zn}$  by either ingestion or injection. Subgroups were then held at 20°, 25°, and 30°C while their  $\text{O}_2$  consumption and  $^{65}\text{Zn}$  elimination rates were determined. Crickets labeled by both methods exhibited a significant correlation between the percentage  $^{65}\text{Zn}$  eliminated and oxygen uptake per gram per hour. For ingestion-labeled animals a  $Q_{10}$  of 1.89 was calculated from  $^{65}\text{Zn}$  elimination data and 2.20 from  $\text{O}_2$  consumption data. For injection-labeled animals a  $Q_{10}$  of 2.29 was calculated from  $^{65}\text{Zn}$  data and 2.55 from  $\text{O}_2$  consumption data. It would appear that direct comparison of  $Q_{10}$  values determined by these two techniques is not valid.

## SPERM AS AN EMBRYONIC SOURCE OF ZINC IN *HELIOTHIS VIRESCENS*

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The transfer of iron and zinc to the female at the time of mating in *Heliothis* was investigated through the use of  $^{65}\text{Zn}$  and  $^{59}\text{Fe}$ . Male *Heliothis virescens* were shown to transfer approximately 36% of their whole body  $^{65}\text{Zn}$  burden to the female at the time of mating. Roughly 5% of the male's and 10% of the female's  $^{65}\text{Zn}$  burdens were found in eggs oviposited for 10 days after mating. No measurable amount of  $^{59}\text{Fe}$  was transferred at mating by *Heliothis*. In this instance embryonic needs are obviously met by maternal sources of the trace element.

Conservation of zinc may be directly related to mating behavior in *Heliothis*. *Heliothis* females mate only once, and at this mating the

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male provides a significant percentage of his zinc body burden for embryo development. If *Heliothis* is required to provide this large amount of zinc at mating, it may well be that one mating is all that is possible.

### PHYLOGENETIC STATUS OF *HEXAPODIBIUS* (TARDIGRADA)

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Phylogenetic status of *Hexapodibius*, a new and rarely found genus is re-evaluated on the basis of large numbers of specimens from two newly discovered populations. Taxonomically important characteristics, including those revealed by the first scanning micrographs of the genus, are discussed.

### EFFECTS OF ASPRIN ON THE DEVELOPMENT OF DARKNESS-INDUCED BUPHTHALMIA IN CHICKENS

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Auburn University Broiler-type chickens were reared for ten weeks under either 12 hours light and 12 hours darkness (12L/12D) or under continuous darkness (0L/24D). Three groups of chickens of each lighting regime received daily oral doses of either aspirin (65 mg/ml corn oil/Kg body wt.), corn oil (1.0 ml/Kg body wt.) or neither.

The ocular trans diameters and eye weights of 0L/24D birds were significantly greater ( $P \leq .001$ ) than 12L/12D birds after 35 and 70 days treatment. Aspirin decreased the trans diameters and eye weights of 0L/24D birds significantly ( $P \leq .05$ ) after 35 and 70 days and of 12L/12D birds after 35 days ( $P \leq .05$ ) but not 70 days.

The aqueous volumes of 0L/24D birds were significantly greater ( $P \leq .001$ ) than the volumes of 12L/12D birds after 35 and 70 days. Aspirin significantly decreased the aqueous volumes in 0L/24D birds ( $P \leq .05$ ) after 70 days of treatment. No changes in aqueous protein (mg) per eye was produced by aspirin or by darkness, despite the concurrent buphtalmia.

MATING AND FECUNDITY OF TEA SCALE

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Tea scale, *Fiorinia theae* Green, is an important insect pest of camellia and holly in Alabama. Details of the biology of this insect are poorly known.

Tea scale broods were reared on butternut squash held in constant temperature cabinets at  $25 \pm 1^\circ\text{C}$ ,  $60 \pm 10\%$  RH, and no illumination. Observations were made under artificial lights. Males were fragile and short-lived, most of them dying within 24 hours. Shortly after emergence, males actively sought females for mating. There was indirect evidence of production of a sex pheromone by females. Males attempted copulation or mated with 1-7 virgin females within 15 minutes.

Females started laying eggs following a preoviposition period of 8 days. Females laid an average of 27 eggs within 30 days, far more than the 10-16 eggs per female reported in the literature. In another test, females of unknown age produced an average of 28 crawlers within 30 days. Additional research is needed to determine the longevity and reproductive potential of female tea scales.

AGING AND *IN VITRO* ADRENAL CORTICAL  
RESPONSIVENESS TO ACTH

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Young (60-70 da) and mature (390-440 da) male rats (SAF/SD) were utilized in a two phase investigation to further assess the interaction of aging with adrenocortical responsiveness to ACTH. During Phase I, adrenal glands were removed from the animals and immediately subjected to incubation in 1 of 4 ACTH levels (0, 100, 200, 400 mU). *In vitro* corticosterone secretion rates were analyzed and reflected (a) significant responsiveness to all ACTH treatments in the young group and (b) lack of responsiveness to the 100 mU but not 200mU and 400 mU levels in the mature group.

In Phase II of the investigation, adrenals were subjected to an initial incubation as in Phase I and were then subjected to a second incubation during which ACTH-stimulation of each adrenal pair was of the same magnitude as in the initial incubation. Glands from both young and mature animals exhibited equal and significantly elevated corticosterone secretion rates in response to each ACTH level utilized.

The data suggest the presence of a possible competitive inhibitor of ACTH activity in the glandular tissue of the mature animal. It is

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further indicated that the activity of the inhibitory factor may be diminished or removed by initial incubation and/or *in vitro* ACTH stimulation as evidenced by the lack of a significant age-ACTH interaction at lower ACTH levels during the second incubation period.

### INTERACTION OF *IN VIVO* OR *IN VITRO* ACTH STIMULATION WITH ADRENAL CORTICAL FUNCTION IN NOISE-STRESSED RATS

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Male laboratory rats (SAF/SD) were utilized to clarify further the interaction of intermittent high-intensity noise with the hypothalamic-pituitary-adrenal cortical axis. Corticosterone secretion rates of paired adrenals from control animals and from animals exposed to a pattern of 60 seconds white noise (110 dB SPL)-300 seconds no noise for 28 consecutive days were analyzed. Glands were either (a) removed from the animal and immediately incubated in the presence or absence of incremental levels of ACTH, (b) removed from the animal and subjected to an initial incubation in the absence of ACTH followed by an ensuing incubation in the presence of incremental levels of ACTH, or (c) removed from the animal 60 minutes after *in vivo* injection of incremental levels of ACTH and incubated in the absence of ACTH.

Glands from noise-stressed animals were unresponsive to low levels of *in vitro* or *in vivo* ACTH stimulation while their control counterparts showed no such lack of responsiveness during the initial incubation phase. After preincubation, control and noise-exposed animals responded equally to all levels of *in vitro* ACTH stimulation. The data suggest the increase of a noise-related systemic factor or factors of unknown origin which has the ability to diminish the expression of ACTH upon the adrenal cortex.

### EFFECT OF PREINCUBATION UPON SUBSEQUENT *IN VITRO* ADRENOCORTICAL RESPONSIVENESS TO ACTH IN AGING RATS

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*In vitro* adrenal secretory rates of corticosterone of young (60-70 da) and mature (390-440 da) male rats (SAF/SD) were analyzed to assess the interaction of aging with adrenal cortical responsiveness to ACTH. Glands were removed from animals and either (a) exposed immediately to incremental levels of *in vitro* ACTH-stimulation or (b) subjected to a preincubation in the absence of ACTH followed by transfer to fresh incubation medium fortified with incremental ACTH levels.



Immediate incubation with ACTH resulted in significant elevations in *in vitro* corticosterone secretion rates at all ACTH levels tested in the young group. However glands from mature animals exhibited significant responsiveness to only the higher ACTH levels utilized. After an initial preincubation in the absence of ACTH, glands from both young and mature animals responded significantly and equally to each ACTH level tested.

The results indicate that previously reported declivities of *in vivo* or *in vitro* responsiveness to ACTH with maturation may be a function of an inhibitory factor or factors, the *in vitro* activity of which is diminished or removed as a result of preincubation.

HISTOLOGICAL STUDIES NAD REARING OF PHYLLOSOMES OF THE  
SLIPPER LOBSTER, *SCYLLARIDES NODIFER*

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The slipper lobster, *Scyllarides nodifer*, is an underutilized species found normally in the deeper waters of the Gulf of Mexico and in the offshore waters in the Gulf stream as far north as North Carolina. Little is known about population density, habitats, reproductive capacity, migratory habits, food preferences or developmental rates. We have attempted to rear the phyllosomes from freshly hatched eggs of two berried females dredged from approximately 150 feet of water in the northern Gulf. Phyllosomes were isolated into 3 control and 5 experimental groups of from 20 to 50 per 100 ml seasoned artificial sea water in 250 Erlenmeyer flasks shaken slowly. The experimental groups ranged from no food added to food, antibiotics and thyroxin. The groups surviving best were control groups and groups treated continuously with thyroxin and antibiotics, and fed *Artemia* (brine shrimp) larvae, which are stabbed by the very motile second maxilliped and quickly placed upon the sucking mouth parts. Widespread bacterial infections could be controlled marginally with antibiotics but fungi eventually killed all animals. The most advanced ones reached at least the second stage (14 day) out of a possible 10 stages of phyllosomal development. The phyllosomes are free swimming, appear to be phototactic and are noncanabilistic. A rearing facility using UV sterilized water is now being constructed and prospects for longer development are good.

Before phyllosomes died, selected ones were fixed in a gluteraldehyde-paraformaldehyde solution and processed for embedding for light and electron microscopy. Light microscopy shows expected components of the animal including well developed muscles for the exopods of the first and second peripods. Micrographs are being organized into an atlas which will eventually show many of the salient macro and ultra-structural features of the development of the lobster larvae into juveniles.



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### ISOLATION AND BIOPHYSICAL CHARACTERIZATION OF THE NUCLEAR POLYHEDROSIS VIRUS OF *AUTOGRAPHA CALIFORNICA*

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The polyhedral inclusion bodies (PIB) of either the nuclear and cytoplasmic types can readily be isolated from homogenates of most infected insect larvae by high resolution sucrose density gradients. However, inclusion bodies from some species, notably, *A. californica*\*\*, are coated with large amounts of lipids, which bind PIBs together with bacteria and other debris and seriously affect the gradient isolation procedure. Any studies on the biochemical composition of the PIBs must use only highly purified materials and a useful enzyme-gradient procedure now has been worked out. First, crude homogenates of the PIBs are treated with hog pancreatic lipase, pH 7.8 for 4 hours. Digests are fractionated on high resolution density gradients with a single narrow zone of PIBs being recovered at a density of 57.5% sucrose. Microscopic analysis of the PIBs shows an extremely clean preparation with PIB size ranges from approximately 3 to 8 microns. Alkaline digests of the PIBs were separated on SDS acrylamide gels into 8 zones ranging in molecular weight from 75,000 to less than 13,000. A similar sample of soluble protein was isoelectrically focused in pH gradients and one band of protein was detected at a pH of 5.8. The acidic nature of this matrix protein suggests that this component of the inclusion body is most likely cellular in origin. Isoelectric focusing studies of uninfected host cell proteins should determine whether the protein exists in cells normally or is virus directed. The disparity between the number of bands detected by SDS acrylamide gels and isoelectric focusing suggests that most of the gel proteins are dimers and polymers.

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\*\* Graciously supplied by Dr. Randy Bell, Western Cotton Research Lab, U.S.D.A., S.E.A., Phoenix, Arizona 85040.

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### PARTICLE SIZING AND ELECTRON MICROSCOPY OF ZONALLY PURIFIED NUCLEAR POLYHEDROSIS VIRUS OF *AUTOGRAPHA CALIFORNICA*

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Isopycnic zonal centrifugation in sucrose density gradients is the accepted method of purifying polyhedral inclusion bodies (PIBs) for either biochemical, biophysical or infectivity studies. The PIBs of the alfalfa looper, *Autographa californica*\*\* were fractionated by this technique for a study of the distribution of particulate sizes, for the numbers of virions per inclusion body, and for the LD<sub>50</sub> of the different size classes. Since the isopycnic approach is based on particle density differences, the approach here was to do a rate (size) separation in sucrose density gradients, isolate the PIBs from the various fractions, determine the diameter and volume of the particles in each fraction, section samples of each fraction for electron microscopy and determine the relative infectivity of each size class. Separations were incomplete and PIB yields low (~50%) due to anomalous sedimentation of the PIBs caused by being significantly contaminated (bouyant aggregates) with insect cell lipids. One hypothesis is that larger PIBs would contain greater numbers of virions than smaller PIBs and would therefore be more infectious. Particle size data from an electronic counter showed that in general the larger PIBs sedimented faster and contained more virions by electron microscopic examination. However, some very large polyhedra, commonly called "cuboidals" were found to have a relative light density, were found often in the lipid layer and contain very few virions. Average diameter for all PIBs was 4.8 to 5 microns while about 95% fell between about 3 and 8 microns for the non-lipid contaminated ones. "Cuboidals" ranged up to 17 microns. Estimated virion contents are 40-65 per smaller PIBs, 150-200 for larger ones and 10-20 for some of the "cuboidals." Virion length is 0.2 to 0.23 microns long, the capsid 30 millimicrons in diameter and the developmental membrane 60 millimicrons in diameter. An estimated 40-50% of all virus were in multiples with about 15% being in groups of 4, 15% in groups of 3 and 15% being in groups of 2. Matrix protein crystal is approximately 38 Å point to point. Infectivity studies are in progress and will be reported elsewhere.

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### UNUSUAL PLANT SPECIES AND HABITATS IN THE CAHABA RIVER VALLEY

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During a floristic survey of the Cahaba River watershed, various habitats along the Cahaba River were studied, and six were identified as unusual. A total of 11 plant species listed as threatened, endangered, or of special concern were found at these sites. Ten of these species are on the Alabama list of threatened and endangered plants and three are on the Federal list.

The localities, designated by county and access road, along with threatened or endangered plant species found at each site, are as follows: Jefferson County (Rd. 143)--*Panax quinquefolium* L., Endangered (Alabama list); Jefferson County (Rd. 62)--*Hypericum nudiflorum* Michaux ex Willd., Special Concern (Alabama list), *Scutellaria alabamensis* Alexander, Threatened (Alabama list); Shelby County (Rd. 29)--*Monarda clinopodia* L., Special Concern (Alabama list), *Trillium decumbens* Harbison, Special Concern (Alabama list); Shelby County (U.S. Hwy 31)--*Trillium decumbens* Harbison, Special Concern (Alabama list); Bibb County (Rd. 27)--*Hymenocallis coronaria* (LeConte) Kunth, Endangered (Alabama and Federal lists), *Croton alabamensis* E. A. Smith, Endangered (Alabama and Federal lists), *Sedum nevii* Gray, Endangered (Federal list), *Cheilanthes alabamensis* (Buckley) Kunze, Threatened (Alabama list), *Andrachne phyllanthoides* (Nuttall) Muell-Arg., Special Concern (Alabama list), *Scutellaria alabamensis* Alexander, Threatened (Alabama list); Perry County (Rd. 47)--*Trillium lancifolium* Raf., Endangered (Alabama list).

In addition to these species, each of these localities supports a rich and diverse flora. In many cases, the habitats are of limited occurrence in Alabama and are noteworthy as such.

### REDISCOVERY OF *LEPTOGRAMMA PILOSA* IN ALABAMA

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*Leptogramma pilosa* var. *alabamensis*, the Alabama streak-sorus fern, was based upon a collection from Winston County, Alabama, reportedly from a locality about five miles east of Double Springs at an elevation of approximately 1,300 feet. In 1960, the population at that locality, a sandstone cliff on the West Sipsey Fork, was completely destroyed by the impoundment of Smith Lake and construction of a new bridge for U.S. Highway 278. This fern was then presumed lost from the Alabama flora. It was not known to occur elsewhere in the United States but had been identified from the Mexican states of Chihuahua and Sonora.

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At a symposium on rare and endangered species of Alabama held in 1975, it was learned that *L. pilosa* had been observed somewhere along the West Sipsey Fork by Mrs. L. C. Smith of Birmingham and indeed was not extinct in Alabama. A concerted effort to determine the status of this species in our flora was undertaken. In September 1975 and April 1976, several colonies of *L. pilosa* var. *alabamensis* were found at the upper reaches of Smith Lake near the Alabama Highway 33 bridge over the West Sipsey Fork, about five miles north of Double Springs. Topographic maps revealed that the elevation of 1,300 feet reported for the original type locality was in error, since no point in Winston County is over 1,000 feet in elevation. The level of Smith Lake is about 500 feet elevation, and *L. pilosa* colonies are about 10 feet above water level.

## GEOLOGY

### URANIUM CONCENTRATION AND ILLITE ORIENTATION IN THE CHATTANOOGA SHALE--A RE-EXAMINATION

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Silverman and Bates in 1961 reported a case of statistical analysis which has become a classic in geologic statistics. They investigated the relation between uranium concentration and an x-ray measure of illite orientation in the Chattanooga Shale of central Tennessee, and concluded that the correlation of these two variables was not significantly different from zero, and from this reported finding drew further conclusions about the origin of the ore.

Regression analysis demonstrates that in fact the correlation is highly significant when the previously unconsidered stratigraphic subdivisions of the Chattanooga Shale are also included in the regression. The statistical analysis is further improved by appropriate transformation of the uranium concentration to either the logarithmic or the square root transform.

The conclusions from this re-examination of old data are that geologists must, as any other statistically oriented investigators, exercise care that the analyses are performed efficiently. Further conclusions about the origin of the ore are unresolved.

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### A PETROGRAPHIC STUDY OF A BIOTITE GNEISS, WAVERLY QUADRANGLE, LEE COUNTY, ALABAMA

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A detailed study of a biotite gneiss was undertaken to determine its petrogenesis. The biotite gneiss unit, located adjacent to Lee County Road 11 at Loblockee Creek, is banded by light-colored, granitic-like "veins" and is overlaid by a coarse-grained muscovite schist. Situated near the Stonewall line within the Dadeville Complex of the Inner Piedmont, the gneiss and schist are interlayered within the Ropes Creek Amphibolite, which is locally injected by pegmatites.

From megascopic and microscopic inspection, two types of "veins" were identified--one of anatectic origin and one of magmatic origin, the latter probably related to the local pegmatites. Hydrothermal fluids are the probable origin of the sulfide mineralization and may have altered a sheared section of the gneiss to a "greisen-like" schist. Modal analysis was employed to try to substantiate these relationships but the results were inconclusive. A comparative chemical analysis should be run to test these results.

### PRELIMINARY STRUCTURAL ANALYSIS OF A METAMORPHIC ROCK EXPOSURE IN THE WAVERLY QUADRANGLE, LEE COUNTY, ALABAMA

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The exposure discussed is located near the Auburn University Fisheries Experiment Station south of U.S. highway 280. This exposure consists of a sequence of micaceous schist and quartzite to the north and Farmville Granitic Gneiss to the south. These rock units strike generally NE-SW, dip to the NW and have been affected by five deformative events. The schist unit exhibits kinkfolds with spaced cleavage indicating D<sub>2</sub> after D<sub>1</sub>, the initial metamorphism with mineral formation. From measurements of the quartzite unit D<sub>3</sub> and D<sub>4</sub>, two periods of superimposed conical folding, is suggested. The most recent deformative event, resulting in the formation of joints, is assumed in this report to be D<sub>5</sub>. Jointing has not been affected by previous deformative events, D<sub>4</sub>, D<sub>3</sub>, D<sub>2</sub> or D<sub>1</sub>.

THE DOSS MOUNTAIN COMPLEX

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A Mafic-Ultramafic complex occupies the core of the Tallassee Synform in the Dadeville Complex of Alabama's Inner Piedmont. This unit is well exposed in the vicinity of Doss Mountain, 6 miles due north of Camp Hill, Tallapoosa County, where it is mapped as eight separate intrusions. Each intrusion shows discordant contacts with the surrounding amphibolites and Camp Hill Gneiss and appears to intrude both units. Two types of intrusions are recognized. The Doss Mountain type consists of concentrically zoned plutons composed of norite and orthopyroxenite. Cumulate textures, with primocrystal orthopyroxene and intercumulus plagioclase, are common in the ultramafic rocks. Both mafic and ultramafic rocks display intense alteration to tremolite, anthophyllite, chlorite, garnet and talc. The Slaughters type consists of olivine gabbro and hornblende gabbro with subophitic and gabbroic textures. Alteration of these rocks is uncommon. Chemically, the two types are distinct: The Doss Mountain type is *q* normative with  $hy > di$ , whereas the Slaughters type is *ol* normative with  $di > hy$ .

ON THE STRUCTURE AND AFFINITIES OF A CRETACEOUS  
CONIFER CONE FROM GREAT BRITAIN

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A well-preserved conifer cone has been discovered in a block of Cretaceous age limestone on the beach near Osmington Mills in Dorset. The cone which measures  $4.5 \times 5.0$  cm in diam is broken into 3 fragments of lignitic material and embedded in a coarsely crystalline limestone. Seed and cone-scale tissues are slightly flattened and show cellular preservation. Material was prepared by an infiltration of cone pieces with epoxy, serial cellulose acetate peels, and thin sections. Individual seeds were embedded in glycol methacrylate and sectioned with a rotary microtome. The spirally arranged cone-scale complexes encircle a large pith 1.6 cm in diam. There is one recurved ovule embedded in the surface of each ovuliferous scale. Structure of the cone is comparable with those of some members of the genus *Araucaria* (family Araucariaceae) especially the sections *Eutaeta* and *Bunya* that have prominently winged cone-scales. Cone and seed tissues are compared to the ovulate cone *Araucaria mirabilis* from the Jurassic Cerro Cuadrado Petrified Forest in Patagonia and other fossil members of the Araucariaceae.

## Abstracts

### HISTORICAL OVERVIEW AND GEOLOGIC FACILITIES OF ALABAMA'S RED MOUNTAIN MUSEUM

Steve Mann and Marcia Simon  
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Construction on the Red Mountain Expressway cut began in 1963. Seven years later, it was completed. Nearly seven years after that, something that many people had only dreamed about became a reality, the Red Mountain Museum.

The Red Mountain Museum currently consists of a construction crew, an education staff, an exhibits staff, and a special projects and public relations department.

The facilities include the museum building, the Red Mountain Museum walkway, an auditorium, offices, and a research and exhibits construction laboratory.

The Museum building is presently being doubled in size. Work should be completed by this summer.

The museum describes physical and historical geology, and vertebrate and invertebrate paleontology and neontology.

The museum plans continued expansion of exhibits. Soon the museum will have vertebrate fossils, paleozoic dioramas, and a fossil insect in amber exhibit.

Most of this activity parallels the paleontological research the museum is doing. We are currently building a fossil reference collection.

Educationally, the museum has been working very closely with the schools of the area. The museum has also elicited the aid of the Junior League. A series of seminars are offered to the public and a media center comprised of geologic information is being accumulated.

Future plans include the diversification of exhibits. There will be a health and anatomy museum, a pioneer village, an Indian museum, and a children's museum.

The Red Mountain Museum has great potential for growth and will add greatly to the Birmingham area and the State of Alabama.



## Abstracts

### GROUND WATER HYDROCHEMICAL INVESTIGATIONS, LAS VEGAS, NEVADA

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Chemical analyses of major dissolved constituents in near-surface ground water, defined as ground water within the upper 50 feet of alluvium, reflect general differences in surficial alluvial lithologies in Las Vegas Valley, Nevada.

Las Vegas Valley is an alluvium-filled valley in the Basin and Range physiographic province. Based on surficial geologic mapping, defined units, composed of intermixed clay, silt, sand, and gravel-sized alluvium, can be classified as either a carbonate or sulfate lithofacies.

Developed hydrochemical facies and trilinear diagram of dissolved ions indicate that near-surface ground water has a predominantly calcium-magnesium, sulfate-chloride hydrochemical facies with a slight bicarbonate anion facies shift exhibited by those data originating in carbonate lithofacies. A plot of sulfate versus theoretical carbonate thermochemical activity in ground water further substantiates correspondence between carbonate and sulfate lithofacies and near-surface ground-water quality especially when a high magnesium to calcium ratio is considered. Mineral solubility calculations indicate that near-surface ground water is supersaturated with calcium carbonate.

Areal distribution of lithofacies and of hydrochemical facies in both the vertical and horizontal planes, and thermochemical investigations indicate that surficial lithofacies exert partial quality control on ground water within 50 feet of land surface.

### HEAVY METAL DISTRIBUTION IN SELECTED SOUTH ALABAMA RIVER

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Thirty-three water samples were collected along a ninety-three mile stretch of river between Jackson, Alabama and Mobile, Alabama along the Tombigbee-Mobile River. These samples were analyzed for the heavy metals Zinc (Zn), Cadmium (Cd), and Copper (Cu), by Atomic Absorption Spectrophotometry. The maximum value for Zinc was 500 ppb, 60 ppb for Cadmium, and 980 ppb for Copper. Generally, the higher values could be directly attributed to industrial sites.

## Abstracts

### SHORELINE CHANGES ON THE MOBILE BAY COAST OF LITTLE DAUPHIN ISLAND

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Both erosional and depositional responses to coastal processes were observed. Sediments deposited by dredges are the major source of sediment, since the westward transport of sand from Mobile Point is now cut off by the dredging of the shipping channel.

The southern portion of the island is affected by erosion more than other parts of the island. Trees and grasses are most effective in inhibiting erosion, which is most noticeable on the southern portion of the island. Beach slopes vary from 6 degrees in fair weather to 10 degrees in foul weather. In some locations soil units are exposed by sub-aqueous erosion. Heavy minerals make up less than 25% of the beach sands. Sand ripples parallel the beach during fair weather and shift to a more northerly orientation during foul weather.

The central portion of the island has a wider beach with a more gentle slope and a heavier mineral concentration. Close attention was given to erosion and deposition at an intermediate position between Bayou Matagua and Big Pass Margaret and the erosion, breaching, and re-joining of Big Pass Margaret.

The northern part of the island has a narrower beach with a gentle slope and few heavy minerals. Accretion is most noticeable at the northern end of the island.

Little Dauphin Island represents a dynamic but reasonably stable beach.

### SHORELINE CHANGES AT THE WEST END OF DAUPHIN ISLAND, ALABAMA

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A short-term study of shoreline processes is essential in understanding the overall dynamic changes of the downdrift terminus of an island. Factors to be considered are wave refraction, longshore currents, wind directions and any features that develop such as runnel systems, tidal pools and spits.

Dauphin Island is migrating westward as evidenced by deposition and elongation at the western tip of the island. Factors contributing to this migration include: the general direction of waves from the south-east, which transport sediment to the northwest where the wave refract

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around the end of the island; the westward trend of the longshore current; and the general direction of the wind from the south. This conclusion is supported by a study of Dauphin Island done by the Geological Survey of Alabama (1974) with the use of maps, charts and photographs.

### GROWTH AND FORM OF PENTREMITES

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Absolute size measurements are so subject to environmentally induced phenotypic changes that they are useless taxonomic criteria. Using ratios or indices is equally misleading since in allometric growth, ratios of original variates change continuously and in a regular manner relative to size.

Galloway and Kaska (1957) studied *Pentremites* and found that of the 133 assigned species of *Pentremites*, 63 were valid, 30 were synonyms or unrecognizable, 30 belonged to other genera and 10 were nomina nuda. Mistaken taxonomic distinctions have been based upon the assumption that the shape of individual *Pentremites* did not change during ontogeny. Quantitative ontogenetic and morphological studies into blastoid genera and the use of growth patterns for taxonomic criteria may clear much of the taxonomic confusion of *Pentremites* and other blastoids. The three species of *Pentremites* used in this study are *P. godoni*, *P. pyraformis* and *P. robustus*.

### FORESTRY, GEOGRAPHY, AND CONSERVATION

#### ALABAMA'S WIREGRASS: IMPLICATIONS OF THE REGION FOR GROWTH AND ADMINISTRATION

Lawrence A. Brown  
The Troy State University System

The extreme southeastern counties of Alabama and the adjacent portions of Georgia and Florida are included in the region known locally as the Wiregrass. The area is emerging as one of the newer growth poles of the Sun Belt. Traditional dependence upon mixed farming, with an emphasis on peanuts, and labor intensive industries, such as textiles and the processing of agricultural goods are now being overshadowed by capital intensive and relatively pollution-free activities. In addition, the region's mineral deposits are being developed on a large scale.

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Economic diversification has become a byword in the Wiregrass. The region's function as a retirement center for military and civilians is enhanced by excellent health and recreational facilities. As a result of the area's rapid growth, various groups have been organized to scrutinize potential industries with the intent of maximizing the region's economy while maintaining a high degree of environmental quality.

### POLITICAL GEOGRAPHY AND PHILATELY: EXAMPLES FROM LATIN AMERICA

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Many nations have issued postage stamps on which maps appear. Such stamps as have been issued by Latin American states belong to one of three categories.

"Map stamps" in the first category do not portray any significant external national relationships. This class of stamps includes commemoratives of different kinds in which the map shown is merely a graphic symbol of the nation.

The second group of "map stamps" shows only very simple external relationships, such as air routes between different countries.

The final category is that which most directly relates to political geography. Most commonly, stamps in this group portray areas, the sovereignty of which has been questioned. Examples of such stamps involve areas that have been or are in dispute between Ecuador and Peru, Bolivia and Paraguay, Venezuela and Guyana, Honduras and Nicaragua, and Guatemala and Belize. In some of these cases the postage stamp has been used in a very interesting and colorful manner to support claims to the disputed territory.

### FIRSTS IN FORESTRY AT AUBURN UNIVERSITY OVER HALF A CENTURY

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Forestry research in Alabama had its beginning in 1927 at the Alabama Polytechnic Institute (now Auburn University) under the direction of a horticulturist L. M. Ware. He and his associates felt that cutover forest lands and lands burned by wild fire should again grow trees. An early need, if tree planting was to be successful, was the control of wild fire. Early demonstrations of the growth of southern pines at different spacings and the effects of wild fire on forest vegetation can still be observed on the Auburn campus.

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Forestry education had its beginning in 1946 when courses were first offered leading to a 4-year degree in Forestry. Enrollment through 1977 has ranged from a low of 75 to 325. Graduate programs have been offered beginning in 1952. Two endowments in support of Forestry date back to 1952. A number of scholarships and awards have been made available from endowment funds and by forestry groups and industries.

Three buildings have been constructed to house the programs of the Department of Forestry that was created July 1, 1947. The first was finished in 1948 and added to in 1970. A Forest Products Laboratory was dedicated as recently as 1977.

### SPATIAL STRATEGIES IN RAILROAD PLANNING IN GEORGIA AND THE CAROLINAS, 1830-1860

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The main objective of railroad planning in Georgia and the Carolinas before 1860 was to secure control over a particular trade territory and to exclude competition. Investment in line construction was the main tool employed by ports and interior trading centers for expanding their spheres of influence. Political manipulation was the main tool used for preserving territorial integrity and trade monopoly. The result by 1860 was a railroad network comprised of a series of substantial, but relatively discrete short trunk lines. These systems flowed much like the rivers of the area, draining from the Piedmont to the Atlantic Coast. They were controlled largely by the capital and the votes of the major ports and were primarily sustained by the profits of transporting the agricultural produce of areas served by the system to the coast.

The development of the railroads as a transportation mode was an innovation to the southeast in more than the simple technological sense. Railroads were extensive and expensive installations involving much more in the way of benefit and locational analysis than the piecemeal road and canal construction which had gone before. The railroads were in effect the first of the truly large scale "planned public works" programs in the southeast. The historical geography of their development indicates the widely perceived importance of spatial considerations in public works planning at this early date.

### DEMOCRACY IN AFRICA

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Democracy as a political system including majority rule, broad suffrage, political competition, and a free press is virtually non-existent

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in Africa. A survey made for this study shows that of fifty-two states examined only five were found to be democratic: Botswana, The Gambia, Djibouti, Mauritius and Transkei.

In the remaining forty-five states the governmental system was totalitarian either by an autocratic monarch (3), military leader or council (9), one-party system (12) or dictatorships (11). All governments of these states represent very small minorities ranging from two to ten percent of the populations.

Governments in Africa reflect the colonial cultural heritage with the minorities in power the elites developed by the European colonial administrations. Clerks, minor officials, students and soldiers who absorbed European political concepts during the colonial era now comprise governments that keep the indigenous black populations in a state of political impotence. Prospects for real democracy as implied by majority rule in Africa are extremely bleak.

## PHYSICS AND MATHEMATICS

### NEUTRON CROSS SECTIONS FOR $^{93}\text{Nb}(n,\alpha)^{90}\text{mY}$ AND $^{80}\text{Se}(n,2n)^{79}\text{mSe}$ AT 14.1 MeV

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Activation techniques have been used to measure neutron cross sections for  $^{93}\text{Nb}(n,\alpha)^{90}\text{mY}$  and  $^{80}\text{Se}(n,2n)^{79}\text{mSe}$  at 14.1 MeV. Fast neutrons were produced by the  $^3\text{H}(d,n)^4\text{He}$  reaction using 333 keV deuterons from the Auburn University Dynamitron accelerator. Associated particle techniques were used to measure the neutron flux. Absolute cross section measurements were made and compared with the results of others. Experimental values are  $5.1 \pm 0.5$  mb for niobium and  $246 \pm 22$  mb for selenium.

### THE INTERACTION OF 13-17 MeV NEUTRONS WITH $^{58}\text{Ni}$

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Based on the interest in neutron cross sections for first wall constituents of fusion and fission reactors, the neutron excitation

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functions for the  $^{58}\text{Ni}(n,2n)^{57}\text{Ni}$  and  $^{58}\text{Ni}(n,p)^{58}\text{Co}$  reactions have been measured in the 13-17 MeV energy range. Samples of pure nickel oxide were irradiated by neutrons from the  $\text{T}(d,n)^4\text{He}$  reaction. Cross sections were calculated from measurements of the resulting gamma-ray activity of the samples and the neutron flux to which the samples were exposed. A comparison of the experimental results with the semi-empirical calculations of Pearlstein shows that the theoretical predictions provide reasonable estimates for  $(n,2n)$  reactions but are not so trustworthy for reactions yielding charged particles.

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### TOTAL CROSS SECTION MEASUREMENT FOR THE $^6\text{Li}(d,n)^7\text{Be}$ REACTION

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The  $^6\text{Li}(d,n)^7\text{Be}$  reaction has been studied at bombarding energies ranging from 0.75 MeV to 2.50 MeV in 250 KeV steps. Total cross sections have been determined from the yield of the  $^7\text{Li}^*$  477 KeV gamma ray. The values obtained were 98 mb at 0.75 MeV, 89 mb at 1.00 MeV, 66 mb at 1.25 MeV, 78 mb at 1.50 MeV, 47 mb at 1.75 MeV, 102 mb at 2.00 MeV, 61 mb at 2.25 MeV, and 57 mb at 2.50 MeV.

### HEAVY ION RESEARCH AND AN EXPERIMENT DESIGNED TO CREATE THE SUPER HEAVY ELEMENT $Z = 114^*$

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The first artificially created element, Neptunium ( $Z = 93$ ) was identified in 1940. Since that time 12 additional transuranium elements have been created and identified. Attention is now being focused on the super heavy elements with  $Z = 114$  and higher. The theory is now about 10 years old that indicates islands of stability around  $Z = 114$  and  $Z = 164$ . Other theorists have found an island of stability around  $Z = 146$ . Searches in nature and experiments at accelerators have failed to identify super heavy elements. This paper describes an experiment designed to produce and identify super heavy elements at an accelerator.

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\* Invited paper.

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EXPLOSIVE INSTABILITIES IN A BEAM PLASMA

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We have studied the evaluation of the explosive instability in an electron beam-plasma system with three types of computer experiments, a particle-in-cell simulation as well as two different fluid models. The explosive instability can occur when three waves with positive and negative energies resonantly interact in a plasma. The instability is characterized by a growth rate which is greater than exponential. The computer results show good agreement with the usual mode coupling theory derived from the Vlasov equation until the growth terminates. The simulations indicate that the saturation results from a mismatch in the frequencies of the wave triplet due to the nonlinear frequency shift caused by trapping of electrons in the potential wells of the waves. Two members of the explosive triplet are observed to Landau-damp due to the heating of the electron distribution by trapping.

BETA RADIATION AUTORADIOGRAPHY AS A TECHNIQUE  
FOR RESTORING FADED PHOTOGRAPHIC IMAGES

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When a photographic emulsion is exposed to beta radiation the latent image is formed much more efficiently than for exposures due to visible light. This efficiency is utilized in the autoradiographic technique for restoring faded photographic images. Badly faded or underexposed photographs actually contain most of the information which was intended to be recorded by the original exposure. The information is stored as elemental silver but the total amount of silver is too small for easy detection by visual means. In the application of autoradiographic intensification, the silver atoms are made radioactive by chemical combination with a beta emitting isotope, sulfur-35. When a second emulsion (the autoradiograph) is exposed to this beta radiation, the original image is transferred with increases in density and contrast so that images which were invisible or barely visible on the original are easily seen on the autoradiograph. A practical technique for autoradiographic intensification which was developed at Marshall Space Flight Center for use in astronomical research has proven to have applications in many other areas. Recently this technique has been applied to the restoration of the image of old, faded photographs of historical significance.

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### A SIMPLIFIED COMPUTER MODEL FOR CURRENT FILAMENTATION IN SILICON-ON-SAPPHIRE DEVICES

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Instability in current configuration of a thin-film silicon-on-sapphire device occurs at temperatures above the turnover point of the resistivity-temperature curve. A computer simulation study of the process of current filamentation in silicon on sapphire devices using a simplified model has been done. This model basically divides the device (420 microns long, 100 microns wide with a film thickness of .4-.8 microns) into a network of strips. A series of one-dimensional simulations yielded junction behaviors, i.e., the equations of state of the junction as a function of current density ( $1.e7-1.e9$  a/m<sup>2</sup>), doping concentration ( $1.e20-1.e24$  #/m<sup>3</sup>) and temperature (200-1600 K).

Constant current pulses of intermediate duration (5-25 microsec) and amplitude (15-50 ma) were applied, and a heat flow equation (that includes both thermal and electrical effects) was solved to obtain a series of steady-state solutions specifying complete state of the device at given intervals of time. Continued iterations advance the device towards the filamentation stage. Single, narrow current filaments extending all the way from p<sup>+</sup> to the n<sup>+</sup> region have been obtained.

### VALENCE-BAND STRUCTURES OF THE BINARY COMPOUNDS AND TERNARY ALLOYS OF ZnS, ZnSe AND ZnTe

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The valence-band structures of the II-VI compound semiconductors ZnS, ZnSe and ZnTe and their ternary alloys are studied using the bond-orbital model (BOM) and the coherent-potential approximation (CPA). The BOM is truncated at the third-neighbor interactions. These interactions were derived by fitting to the X-ray photoemission spectra (XPS) and photoelectric thresholds. The line shapes and the locations of the prominent peaks of the calculated densities of states (DOS) are in good agreement with the XPS. The CPA DOS for the II-VI alloys were found to be more interesting than those for the III-V ternaries previously studied in that these DOS begin to differ appreciably from the virtual-crystal results. Our study also includes the more detailed band properties such as energy shifts, line broadening and effective masses. The large non-linear concentration dependence of the top of the valence band is found to correlate well with the large experimental bowing parameters for the  $E_0$  gaps.

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### POTENTIAL AND ELECTRIC FIELD DISTRIBUTION INSIDE SEMICONDUCTOR p - n JUNCTIONS

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In this paper I have tried to plot the Potential and Electric Field distribution inside depletion region using Integral Equation. I converted the non linear differential equation to its Integral Equation and then solved it by Iteration method for an ABRUPT p - n Junction case. I used two iterations and then plotted the potential and Electric Field distributions which shows the effect of Iterations using numerical method. To generate the values for iterations confonterized output was used.

### THE POLARIZED ABSORPTION SPECTRA OF $\text{Ho}^{3+}$ IN YTTRIUM ORTHOALUMINATE AT 77°K

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The upper Stark levels corresponding to the  $5\text{I}_5$  through the  $5\text{G}_2$  manifolds of  $\text{Ho}^{3+}$  in  $\text{YAlO}_3$  were determined by examining the polarized absorption spectra the 0.5 mole %  $\text{Ho}^{3+}$  dopant. Measurements covering a range from 880 nm to 360 nm were recorded using a Jarrell-Ash 3.4 meter spectrograph. The spectra were analyzed using published "free ion" energy level calculations<sup>1</sup> and the ground state splittings as given by Weber and Bass.<sup>2</sup> In addition to the Stark splittings of these manifolds, the corresponding irreducible representation state labels have also been determined. Assignment of irreducible representation labels for some manifolds was difficult due to ambiguities in the polarized absorption spectra.

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\* National Science Foundation Undergraduate Research Participant.

<sup>1</sup>W. T. Carnall, P. R. Fields, and K. Rajnak, J. Chem. Phys. 49,4424 (68).

<sup>2</sup>M. J. Weber and M. Bass, Raytheon Co., Tech. Rep. AFML-TR-72-32, Waltham, Mass. 1972.

## Abstracts

### A TERNARY ALGEBRAIC SYSTEM

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In most of the algebraic structures a nonempty set with one or two binary operations is considered.

The objective of this paper is the presentation of an algebraic system with a ternary operation. Also some relationship between this system and the abelian groups is given.

### THE DECLINE IN SCHOOL MATHEMATICS

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Evidence of a decline in school mathematics consists of lower scores on standard mathematics tests and increase in remedial courses offered by college mathematics departments. Various factors mentioned as causes include the new mathematics introduced into the schools in recent years, decline in reading ability, shifting interests in academic matters, use of hand calculators and other items. It is difficult to point to specific causes. At the same time there is great improvement on the part of good students as evidenced by advanced placement in college mathematics programs and stronger courses for better students. Along with poor performance in mathematics many school systems are now considering minimal competencies in mathematics either for promotion to higher grades or for graduation from high school.

### MULTICHANNEL ANALYZER RECORDING OF SINGLE PHOTON COUNTING MONOCHROMETER DATA

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Single photon counting monochrometer data are taken using a multi-channel analyzer in place of a count rate meter. Interfacing and typical results are discussed.

## Abstracts

### PROBLEMS IN THERMO-THERAPY I

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The historical development of thermo-therapy, a century old clinical treatment analagous to the natural fever, is briefly sketched. The advantages and limitations of thermo-therapy as a cancer treatment are discussed with particular emphasis on the use of localized R.F. heating techniques. Problems of energy absorption and heat transfer within biological tissues are delineated in the light of desiring to place thermo-therapy on the same footing as radiation therapy.

### PROBLEMS IN THERMOTHERAPY II

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The basic theory of radio-frequency diathermy discussed in part I illustrated the need for determination of the complex electric permittivity and the heat diffusivity of human biological materials. Techniques for determining these values are discussed and some of the pertinent equations are derived. Particular attention is paid to the micrometer electrode system and its use in resonance-rise circuits. Other problems, such as sample aquisition and storage are also discussed.

### DEGREE DAYS AND SOLAR ENERGY FOR SOLAR HEATING IN HUNTSVILLE, ALABAMA

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The interest in solar energy as an alternate source of energy has increased considerably in recent times. The advantages of solar energy are obvious: it is clean, inexhaustible (at least for the next 100-200 years), and allegedly free of charge. The latter is limited to the source only, the costs lie with the hardware for collection and storage of solar energy.

If solar heating of houses should become more attractive in the future it is essential that cost effective systems be designed which supply heat through the entire winter. Then the climatological background for these heating systems cannot be ignored.

Unfortunately, data are not available to prepare a complete climatological data base, partly because only mean values of solar radiation

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and temperature are published. The author has analyzed the past two winters in Huntsville, Alabama, as an example of how a solar heating system would properly function. The analysis proved that degree days and solar energy must be examined jointly, and average values are insufficient.

The author based the calculations on the postulation  $D/D_R = L/L_R$ : an increase in degree days ( $D$ ) implies the same increase in solar radiation ( $L$ ), whereby the references  $D_R$  and  $L_R$  are left open for definition. A reasonable choice for  $D_R$  is the average degree day in January while  $L_R$  is a selected solar energy threshold, in general lower than the January average. Under this concept the storage capacity would require a 27-day supply for  $L_R = 192$  Langleys per day (January average), and an 11-day supply for 140 Langleys per day. While a reserve of 25 days must be available on 1 December for the system of  $L_R = 192$ , the second threshold requires only a one day reserve.

It is obvious that the system based on  $L_R = 192$  Langleys per day requires a smaller collector area than for  $L_R = 140$ . The optimum cost effective system can only be determined in a trade-off between size of storage (capability) and collector area. This trade-off depends on hardware costs, and must be calculated individually from the hardware specifications of the system. The trade-off calculation cannot be properly carried out, however, unless data on the solar energy deficit as a function of time and availability of carry-over energy on 1 December are available in various climatic zones.

### A PRECISION STRONTIUM-90 IRRADIATOR

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A Lucite container was designed and constructed to enclose an encapsulated strontium-90 source for use as a beta irradiator. A timing power driver was also designed and constructed to control and measure irradiation times. Specifications of the container and the theory of the timer and associated electronics are given. Total error of irradiation time is also given.

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### INDUSTRY AND ECONOMICS

#### SOCIAL SECURITY AND LABOR FORCE PARTICIPATION OF OLDER MALES: 1947-1976

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Regression analysis was applied to time series data to determine the impact of certain aspects of the Social Security Act upon the 1947 to 1976 downward trend in labor force participation rates of two groups of older men: men age 55 to 64 and men age 65 and over.

The tests of the hypothesis that the labor force participation rates of older males age 55 to 64 have been determined by the opportunity for males age 62 to draw reduced social security benefits created by a 1961 amendment to the Social Security Act, the general level of job opportunities, and the level of employment opportunities available to men in this age group, offer evidence that the opportunity for early retirement and the general level of job opportunities have contributed to the decline in the number of males in this age group participating in the labor force. Findings do not indicate that declining employment opportunities available to these men explain the decline.

Tests results show little evidence in support of the hypothesis that the declining 1947-1976 labor force participation rates of older males age 65 and over have been determined by the increasing value of social security benefits relative to earnings opportunities from market work, the general level of job opportunities, and the employment opportunities available to males age 65 and over.

#### A MODEL TO PROJECT LOSS OF EARNINGS FROM IMPAIRED OR DESTROYED CAPACITY

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Attempts have been made for many years to place a monetary value on human life. Rather than becoming easier over time, determination of a value has become more difficult especially within the past 25 years. accuracy of estimates are reduced because of uncertainties associated with changing economic and social conditions. For example, the importance of the variables used in this analysis has intensified within recent years because of the changing nature of the American economy, coupled with expanding social programs. Particularly important among the variables affecting earnings are occupational alternatives, education, age, productivity, inflation, and interest rates.



Despite the restraints noted above, a methodology exists for conceptualizing these factors into a systematic economic approach for estimating and projecting individual earnings. This article has utilized a methodology to relate economic concepts to the problem of establishing a monetary value of lost earnings due to impaired capacity or death. It essentially involved determination of the difference in expected lifetime earnings prior to and after the occurrence of impairment or death and discounting this difference to a present value.

### THE ECONOMIC IMPACT OF AUBURN UNIVERSITY AT MONTGOMERY

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The purpose of this paper is to present the findings of a study to determine the economic impact of Auburn University at Montgomery on the City of Montgomery and Montgomery County. The study was designed to measure both the direct and indirect impacts of additional spending in the Montgomery area as a result of the establishment of AUM. The period of the study covered five fiscal years beginning with 1972 and ending with 1976.

Three basic types of expenditures were analyzed: operations and salary expenditures, construction expenditures, and spending by out-of-county students. To determine their pattern of spending and the potential indirect or multiplier effect of their spending, a survey was conducted of the faculty and staff. Additionally, a simpler survey was conducted of non-Montgomery County students to determine the level and breakdown of their Montgomery County expenditures as a result of their student activity.

The basic methodology of the study involved the development of a spending multiplier to measure the impact of spending beyond the first injection of spending from direct university funds. Basically, the concept of an economic multiplier is as follows: when additional injections of spending occur in the economy, the funds spent become additional income to other individuals, who re-spend it, generating additional income for others. In the course of a year, the impact of adding spending will be some multiple of the initial injection of spending. To calculate the value of the multiplier, the "leakage" from the spending flow must be known. A leakage is non-spending. Savings and tax payments are the principal leakages normally considered. In the case of computing regional multipliers, as in this study, any spending outside the region is also a leakage and must be considered.

The multiplier for each income class was then calculated by the formula:

$$K = \frac{1}{L} \quad (1-1)$$

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where  $L$  = percent leakage =  $\frac{\text{total leakage in each income class}}{\text{total income in each class}}$

The aggregate weighted multiplier was calculated by the formula:

$$\text{Aggregate } K = \sum_i K_i \cdot P(K_i) \quad (1-2)$$

where  $P(K_i)$  = the probability of a faculty member falling into a specific income class as represented by the percent of total AUM personnel in each class.

The solution to equation (1-2) above was found to be 2.36. AUM and its personnel can therefore generate \$2.36 worth of economic activity by each dollar they spend in Montgomery County.

### A STATISTICAL ESTIMATION OF FARMERS' DEMAND FOR SOYBEAN LOANS FROM THE COMMODITY CREDIT CORPORATION, UNITED STATES DEPARTMENT OF AGRICULTURE, 1954-74

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The commodity credit corporation makes loans available to farmers as necessary and uses the commodity as collateral. The purpose of this article is to identify a structure and to estimate that model of that structure. The estimated econometric model can be used for projecting loan volume of soybeans. Projecting loan volume is useful in estimating the work load of staff of Agricultural Stabilization and Conservation Service in the counties and in State offices.

The demand analysis of the volume of soybeans under loan, to the Commodity Credit Corporation, indicates that there are only three independent variables significantly affecting the loan volume of soybeans. The three variables are: soybean production, foreign shipments of soybeans, and the ratio of market price to support price of soybeans. The difference between the actual and the estimated volume of soybeans under the loan program, especially in the last three years of the period 1954-74 is fairly narrow and therefore, the model can be said to be fairly reliable for projecting the loan volume of soybeans if the price support program is in effect in the future. The two independent variables, soybean production and foreign shipments, are one year lagged variables. The elasticities of soybeans volume under loan with respect to the ratio of market price to support price and with respect to other independent variables were estimated. The elasticities are the coefficients of the independent variables in the regression estimated because all the original variables, both dependent and independent, are transformed into logarithmic values to the base 10 and included in the regression. The regression equation with six independent variables included in the model

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explains about eighty-eight percent of the variation in the loan volume of soybeans under loan.

### CONFLICTING GOALS IN IMPROVING THE FISH MARKET INFRASTRUCTURE IN DEVELOPING COUNTRIES

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Economic development agencies have goals of aiding the poor through improved fisheries operations. Programs to aid the sellers often harm the consumers. The poorest element of the society may be damaged by improvements in market infrastructures since prices are raised above their "reservation" level by such actions. The poor are sometimes dependent upon mistakes being made in the market which assure a quantity of lower quality fish within their market domain. The present paper suggests alternatives to fill a low-quality, high-volume fish demand at levels to meet the needs of the poorer classes. Fish culture operations have the flexibility to be directed towards different segments of the market without damaging efficiency of operations.

### GUIDES TO COMPATIBLE RURAL AND INDUSTRIAL GROWTH

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The Southeast in general and TVA region in particular is certain to be subjected to increased growth pressures over the next decades. Quality industrial development is needed to raise the standard of living of many of our citizens.

The region served by the Northwest Alabama Council of Local Governments is predominantly rural but contains the Florence, Alabama metro area. There is increased competition between industry and agricultural sectors over lands within the region.

America is losing approximately 2.4 million acres of agricultural lands per year. We are not insuring that industrial and other urban developments occur so as to retain our best farmland for agriculture.

Coupled with the loss of our agricultural lands, we are facing an increasingly hungry world. This problem could become critical involving our future national security.

Land economics and life style consequences of uncontrolled growth are discussed. Strategies are offered for dealing with our unique situation as well as factors for public decision-making relating to growth.

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The planning process is frequently not viewed as useful in complementing the political process in rural areas. It can be a useful complement.

Rural citizens have responsibilities to insure that they remain compatible neighbors to industrial and other urban activities. Community actions are outlined for promoting a desirable future life style within rural areas.

### A LAND USE PLANNING CONCEPT IN NORTHWEST ALABAMA

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Land use planning has been a concern of planners, land developers, governmental officials, and citizens for the past several decades. This paper discusses land use planning in rural northwest Alabama. The Northwest Alabama Council of Local Governments undertook the responsibility of producing a regional land use plan in order to allow for compatible growth within the region. The land use planning methodology was developed to be sensitive to natural areas, provide accurate information, and stress citizen participation. U.S. Geological Survey maps were used to record a nineteen category land use classification list. Current land use data was identified on USDA Soil Conservation Service air photographs for the entire region. Citizen input was determined from a project notification list. Working papers and a land use task force were used to educate the region's elected officials on land use planning. Future land use projections were determined by calculating development ratios for residential, commercial, and industrial land uses for each county within the region. During the next two years, the planning staff will continue to educate the region's citizens on land use planning by using workshops, lecture programs, issue papers, grade school lesson plans, and a technical information center.

### TOWARD LOCAL CHURCH SELF-SUFFICIENCY

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Many United Methodist churches are small and are located in rural areas. Often these congregations are not able to properly support a well-trained minister. In this situation, the conferences of the church have developed programs of salary supplementation.

As the burden of this aid has grown, the conferences have sought ways of encouraging local self-sufficiency. The measures used include: gentle urging, requirement of every member visitations and annual increases, limitations on the amount of aid granted or the time period over which it may be given, publication of "welfare rolls," incentive

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programs to encourage greater effort by allowing pastors to share in any raises given, formation of multi-church circuits, consolidation of neighboring churches, establishment of "cooperative parishes," and even closing of the weakest units.

Another method which shows much promise in "growth situations," is to significantly increase the supplement temporarily to attract and retain a well-qualified pastor who can expand the congregation, raise membership giving, and place the church on a sound footing, economically as well as spiritually.

### THEORY AS A TOOL

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A common complaint levied against academia is that what is taught in the classroom does not resemble what the student will later experience "out in the real world." The classroom should not purport to be a trial-run of the real world. Its primary purpose is to teach the student how to think independently. It is disturbing how quickly the student will abandon his textbook knowledge on becoming a practitioner. Apparently such a student is unable to make a connected transition between the theoretical world of the classroom to the more complicated world in which he will work.

Theory consists of concepts and terminology that enables us to dissect quite complex phenomena into a few rudimentary patterns of motivation and interaction. The student should force himself to employ theory by consciously interpreting the observable real world in terms of theory. Theory then should be what the student knows best. The purpose of this paper is to reexamine the role of theory in the business school classroom. Emphasis is placed not as much upon its pedagogical role as its role as a kind of "standard of reference." Illustrations are drawn from the business school curriculum, namely, Maslow's hierarchy of needs, the theory of demand and supply, and the capital asset pricing model.

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### SCIENCE EDUCATION

#### A COMPARATIVE STUDY OF CONSUMABLE AND NON-CONSUMABLE USE OF MATHEMATICS COMPUTATIONAL SKILLS MATERIAL AT THE MIDDLE SCHOOL LEVEL

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The purpose of the study was to determine if the use of the Individualized Computational Skills Program (ICSP) material by not writing on it compared favorably with the use of the material by writing on it in terms of student progress in computational skills.

The subjects of this study were 112 students in one teacher's seventh grade mathematics classes at Stone Middle School, Huntsville, Alabama, during the 1974-1975 school year. The ICSP material was used for one-fourth to one-fifth of the total class time. One group of the students wrote on the material (consumable use) and the other group did not write on the material (non-consumable use). The progress, as measured by post test scores of the two groups, was compared statistically.

Four of the null hypotheses comparing pretest and post test scores of the two groups were accepted indicating that writing or not writing on the computational skills material had no significant effect on student progress at the 5% level of significance using the t-test. The fifth hypothesis could not be tested using the statistical procedures of this study because there was a significant difference at the 5% level between the scores of the consumable and non-consumable groups at the beginning of the study. Both the consumable and the non-consumable groups made almost a year's progress in computational skills during the five months of the study, which indicates that the ICSP material is an effective tool for teaching computational skills, and the results of this study indicate that the material could be used non-consumably or consumably with the expectation of equally good results.

Non-consumable use of the ICSP material would be recommended as a cost-effective mode of use.

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### "BLAST-OFF"--AN EXCITING TOTAL INVOLVEMENT PROJECT

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An exciting and inexpensive way to motivate and involve 9th grade physical science students in a hands-on learning experience is with the use of model rockets.

Each student ordered the type rocket he wanted, at his own expense. Some physics students were used as helpers but generally the work was done by the 9th graders.

The class was divided into groups. Each group organized into a Space Ship Company, electing a president, vice-president, secretary, treasurer, sales manager, and production manager. Contracts were drawn up by which the projects were evaluated. When the unit ended a panel of judges came in to judge the displays. The displays included bulletin boards and advertising, the finished rockets, and general organization. Excitement was enhanced by awarding prize ribbons.

In addition to the display the final evaluation included: class work and conduct, launching, obeying safety rules, reports on research, and tests on vocabulary.

Among other things this project required, of the student, skills in the following areas: reading, art, math and measurement, physical science, English, research, economics, and weather. The success of the students and the pride the students took in the finished products were certainly rewarding.

### THE RED MOUNTAIN MUSEUM: A NEW EDUCATIONAL HORIZON

Trudy S. Anderson  
Red Mountain Museum  
Birmingham, Alabama

Breaking the skyline along Birmingham's Southeast boundary is the Red Mountain Expressway Cut--one of the most spectacular engineering and geological phenomena in the Southeast United States. During the Cut's construction, approximately 190 million years of earth history were exposed containing scientific evidence from the Ordovician to the Mississippian Paleozoic Periods in geologic time.

On September 15, 1977, the Red Mountain Museum was officially opened as an educational and research facility offering a walkway along the Cut and housing numerous exhibits pertaining to historical and physical geology. A museum education office was formed to cooperate with area schools in designing a comprehensive educational curriculum for both students and the general public.



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As part of the education program, a preparatory study guide has been developed to ready prospective visitors for a museum tour through geologic time. Training seminars and earth science workshops have been planned in addition to audio-visual and outside speaker presentations. A growing resource center containing geological publications and audio-visual materials has been made available to museum participants.

The museum educational program has been aimed primarily toward the development of scientifically literate citizens. The major goal throughout the process of curriculum design, implementation, and evaluation, has been to nurture cognitive skills as well as basic knowledge. The majority of instructional objectives reflected by the Red Mountain Museum have best been achieved through a process approach to education with emphasis upon a comprehensive presentation of the behaviors which characterize the understanding and use of the scientific method.

### THE ZOO--TO STIMULATE PROSPECTIVE SCIENCE STUDENTS

Dan Whitson  
Austin High School  
Decatur, Alabama

In order to stimulate an interest in science in later school years a program was developed to bring more science experiences to the elementary school student.

With elementary school teachers already hard pressed with several preparations a day and in many cases a limited background in science, an effort was made to relieve them of some of the load and at the same time give the students a good experience in science.

Using senior students, who had a good background in science and a personal interest in the subject, as aides, the services and facilities of the Austin High School science department were volunteered for the use of the elementary teachers.

In addition to the typical laboratory equipment and apparatus, as well as the expertise of the faculty, that was made available, an in-school zoo was established. An effort was made to collect and maintain animals that were easy to maintain and worked well with students in kindergarten through senior high school. At the present the zoo includes: amphibians (frogs, toads, and salamanders), reptiles (snakes, lizards, and turtles), and mammals (mice, gerbils, hamsters, guinea pigs, and rabbits) as permanent residents with various birds, fish, and invertebrates added to the collection as they are available.

Benefits are already being reaped with an average of 25 elementary classrooms visited each year, a few middle school visits, and adding live specimens to the high school biology classes at Austin.

With a minimum amount of work great profits can be realized in years to come by almost any high school science teacher who is willing

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to do something other than complain about the lack of interest their students exhibit.

### INTERACTIVE EFFECTS OF ACHIEVEMENT MOTIVATION AND TEACHING STYLE ON ACADEMIC ACHIEVEMENT IN EIGHTH-GRADE SCIENCE CLASSES

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Red Mountain Museum  
Birmingham, Alabama

The purpose of this study was to assess the existence of interactive effects of achievement motivation and teaching style with eighth-grade academic science achievement in (1) a conforming, and (2) an independent classroom setting. The significance of this interaction effect was examined within the context of a total multiple regression model including additional interrelated control and independent regression variables.

Pretest and posttest data were collected from a criterion-referenced ISCS science achievement instrument. Achievement motivation data were collected from the Achievement via Conformance (Ac) and the Achievement via Independence (Ai) scales of the California Psychological Inventory (CPI). IQ and sex were also used as independent regression variables in the total regression model. Data collected from a Likert-scale teacher selection questionnaire were also observed.

The major findings were: (a) Concerning the total regression model, there was a significant relationship between the values predicted with the model and the values observed for eighth-grade science achievement. (b) Concerning the control variables, the science achievement pretest and IQ accounted for a significant proportion of the variance in the eighth-grade academic science achievement posttest. (c) Concerning the pertinent variable, there was no statistical significance of the variance increment added to the regression by the Ac-Ai-treatment interaction variable. (d) Concerning the background variables, there was statistical significance of the variance increment added to the regression by the treatment variable. However, no significant relationship existed between the remaining independent regression variables (Ac, Ai, Ac-Ai interaction, sex, and treatment-sex interaction) and eighth-grade academic science achievement.

### PHARMACY CBE--A STRATEGY FOR RENEWAL

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In 1973, a review of the pharmacy needs of our society and how these needs were being met was initiated by the Auburn University School

of Pharmacy. Societal needs in pharmacy were translated to educational needs of the school's students. A traditional curriculum had served well in the past, but it was found to be inadequate to meet the needs of today's student and particularly those for the pharmacist of the future. The school systematically analyzed the role of the pharmacist and the projected needs of the pharmacist of the future for the performance expected of the competent pharmacist. The classic method of competency development was utilized to identify and validate the competencies upon which the school would establish the reorganization of its curriculum. Content areas were then generated from the validated competencies. The essential concepts and subconcepts were formulated from the content. Behavioral objectives were developed for the concepts and subconcepts selected and sequenced in sets. These sets of behavioral objectives were then utilized to develop sequences and relationships of the various courses. The assessment of the competencies of the students provides the evaluation for the student and the competency based pharmacy education program.

### COMMUNICATION SCIENTIFIC INFORMATION THROUGH WORKSHOPS

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In 1973 TVA was asked by the regional project technical committee (S-66) to assist in solving problems in housing for rural low-income families. They recognized a problem of communicating research information to decisionmakers. A communication model was adapted to include a workshop as the transmitting device.

Thus, communicating results of research information to those who should be using them became a major part of the new regional project (S-95) beginning in 1973. In 1975 the Quality Housing for Rural Low-Income Families Workshop was held in Atlanta, Georgia. At the workshop: (1) 21 major research-oriented papers were presented, (2) 152 persons attended, (3) six work groups, including researchers, program-oriented personnel, and information-using specialists, produced many recommendations for new policies and programs. Since the workshop: (1) more than 5,000 copies of the proceedings have been put to use, (2) many recommendations have been expanded into other communications activities, and (3) a second regional workshop has been developed.

A survey of the participants was made at the conclusion of the 1975 workshop and again in the fall of 1977 to elicit participant reaction to the workshop and its followup activities as an information disseminator.

Respondents in 1975 indicated that they: (1) "made useful contacts" (84 percent), (2) "gained useful general information" (79 percent), and (3) "received helpful specific information" (59 percent). The responses to the 1977 followup survey indicate that many participants actually had made use of the information gained and the contacts made at the first

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workshop. In fact, responses to both instruments indicate a great deal of interest in future workshops on housing for the rural poor.

An evaluation of the workshop showed that the program objective had been met. The goals of the S-95 research group had been satisfied to some degree. And participant goal satisfaction coincided with the overall goals of the workshop.

Workshops of this type may warrant some measure of success if the basic components of good workshop planning are adhered to. Some of these are:

1. Assessing the needs of the participants.
2. Developing meaningful objectives.
3. Planning activities to coincide with the objectives.
4. Engaging in continuous feedback.
5. Ensuring followup activities.

### THE PRESERVICE PREPARATION OF SCIENCE TEACHERS AT THE UNIVERSITY OF ALABAMA

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The preservice science teacher education program at The University of Alabama consists of a four-semester sequence of classroom, laboratory and field experiences designed to acquaint the students with a variety of skills believed to be necessary to successful teaching; to provide the students with opportunities to develop these skills to an acceptable level of competency, to observe these demonstrated by experienced teachers, and to demonstrate his or her own proficiency in a classroom setting.

The first semester of the four-semester sequence is planned to acquaint the prospective teacher with the realities of teaching. The course is divided into four four-week blocks of time, with the students alternating between four weeks of classroom instruction and four weeks of observing and assisting a practicing teacher in the public school. Specific teaching skills of questioning, positive reinforcement, classroom management, silence and nonverbal cues, stimulus variation, set induction, closure, and the preparation and use of audiovisual aides are studied in the classroom phase of the program. Students are provided frequent opportunities to demonstrate their level of competency in the various skills through microteaching situations. Four weeks assisting a teacher in a junior high school, followed by four weeks assisting a teacher in a senior high school provide opportunities to work with secondary school students having a broad range of maturity, abilities and interests, and to observe experienced teachers functioning in two totally different learning environments. At the completion of the semester each student will have decided: (1) whether he or she wishes

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to pursue a career in teaching, and (2) the grade level at which he or she wishes to teach.

It is assumed that when the students enroll in the science methods class the decision has already been made to pursue a career in teaching; therefore, the focus of the class is on those problems to be encountered by beginning teachers. Questions are posed and answers to these questions are sought through a variety of classroom activities and assignments.

Having already demonstrated an acceptable level of competency in a variety of teaching skills, the students now focus their attention on understanding other aspects of science teaching. Attention is given to numerous areas of special concern to the science teacher, including lesson planning; designing classroom and laboratory activities; sources of supplies and equipment, films, and free and inexpensive materials; student investigations and science fairs. Certain areas of concern are required study for all members of the class; others are to be selected on the basis of the student's particular interest or need. Observation in the public schools, field trips and microteaching complement the more structured classroom activities.

Questionnaires distributed to students who have followed the four-semester sequence indicate a level of competency considerably higher than that attained by students prior to the implementation of the program. There also appears to be evidence of a greater commitment to teaching and increased self confidence as a result of participation in the program.

### A 1¢ PHYSICS DEMONSTRATION, THE EGG AND THE PIE PAN, AND "KITCHEN" INDICATORS FOR ACIDS AND BASES

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Two inexpensive and dramatic physics demonstrations are presented. The first illustrates centripetal force by twirling a penny on a coat hanger. The second, an impressive inertia demonstration, allows you to "shoot" an aluminum pie pan out from under a raw egg without horizontally displacing or cracking the egg.

The "kitchen" indicators presented in the third demonstration are tea, red cabbage, blueberry and blackberry juice. The red cabbage and the tea are good with both acids and bases while the berry juices are most dramatic with bases.

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### SPEECH COMPRESSION AND EXPANSION: AN APPROACH TO THE TEACHING OF AEROSPACE SCIENCE CONCEPTS

Ernest D. Riggsby and Dutchie S. Riggsby  
Columbus College  
Carole Rutland  
Muscogee County Schools

Based upon the knowledge that students are able to listen to the spoken word at rates considerably faster than most persons normally speak, and upon the knowledge that there is a very wide variation in the comfortable "listening rate" of students, this project was undertaken. Three different narrators (lecturers) were utilized for the project. A male voice speaking at a rate of 125 w.p.m., a female voice reading at 130 w.p.m., and a second female speaking at 134 w.p.m. Through the use of the Varispeech I speech compressor/expander, we were able to vary the delivery rate from as slow as 63 w.p.m. to as rapid as 268 w.p.m. A full range of different speeds were used with the students in the project. Tests to measure comprehension and retention were applied. Students were also asked to tell the teacher when they were "comfortable" with the speed of the materials being monitored. With no listening training, students were able to receive, comprehend, and retain information with no losses (compared to normal speaking rate). At speeds of up to 15% increases, students improved slightly in comprehension. At speeds of 35% increase, students began to suffer losses in comprehension. The equipment used in this presentation/demonstration is the equipment which was used in the project.

## SOCIAL SCIENCES

### UP THE TOMBIGBEE WITH THE SPANIARDS: JUAN DE LA VILLEBEUVRE AND THE TREATY OF BOUCFOUCA (1793)

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University of Alabama in Birmingham  
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Although previous histories of Alabama have portrayed Spain as ineffective in blocking American expansion into the Old Southwest, the documentary history of the land cession signed at Boucfouca (near present-day Jackson, Mississippi) on May 10, 1793, indicates otherwise. With the payment of about \$1,000, Spain obtained from the 26 chiefs and captains of the Small District division of the Choctaws about 25 1/2 acres in northern Alabama. There, on the site of Old French Fort Tombecbé, where the Americans would subsequently build Fort York of the British ruined fort (1764-1780), in 1794 the Spaniards built Fort Confederation, named for the alliance signed at Nogales (October, 1793)



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between the Spaniards and the Southeastern Indians. Juan de la Villebeuvre, a native of Rennes in Brittany, not only solidified the Choctaw alliance which he had helped create during the American Revolution, but he went on to serve as the commandant of Fort Confederation just before its evacuation in March, 1797, in keeping with the terms of the Treaty of San Lorenzo. For several years during critical times Spain had checked the westward expansion of the United States, and the Tombigbee-Tennessee dreams of westerners would have to wait almost two centuries.

### THE FORK IN THE ROAD OF THE NEW SOUTH: HENRY W. GRADY v. GEORGE W. CABLE

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Both Henry W. Grady and George W. Cable were irrepressible young men on the make in the New South. Each in his way was a reformer, each was most interested in changing the pattern of the South. Today, without doubt, Grady, the Atlanta Constitution editor, is the best known; however, Cable, the New Orleans novelist, is more in step with today's times.

The approach for change of Grady was primarily economic with diversification and industrialization replacing King Cotton. The American Creed was modified by a Southern Creed whereby with the inherent inferiority of the blacks there was a need for white supremacy. At the same time Grady stated that it was impossible for the people of the South to get along without the blacks. Northerners were to understand, according to the Atlanta editor that Southerners while revering the Lost Cause, were very much on the outlook for Northern capital and factory sites.

George Washington Cable maintained that he spoke for "a silent but intelligent majority of the Southern people, whose views were not represented by newspapers and politicians, yet who could be expected to act fairly and justly if given the chance." Class rule to him was un-American. He rebutted Grady's contention that neither race wanted civil rights by the assertion that the blacks had been praying for twenty years for them. The views of Cable would largely be accepted in the South following the Civil Rights Revolt of the 1960's.

### REASONS FOR RAPPROCHEMENT AND REACTION: A LOOK AT JAY'S TREATY

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University, Alabama

John Jay's mission to Great Britain in 1794 was a curious one. Federalists, such as he and Alexander Hamilton, feared war with England



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and were anxious to ease deteriorating relations with the mother country. War, they knew, would mean the total collapse of Hamilton's financial system. Certainly a negotiating table seemed more desirable than a battleground in settling a fledgling nation's major grievances with a dominant world power. Jay's Treaty succeeded in that it brought a temporary peace. Many Americans, however, felt the price was too high. Upon examining the treaty, one finds that the concessions to the British far outweighed those made to the Americans. The reasons are not difficult to discern.

From the British standpoint, Jay was an excellent choice as chief negotiator. Not only was he easy to manipulate, but his bargaining positions were unknowingly undermined by the actual architect of the treaty, Hamilton. The latter's confidential relationship with the British minister, George Hammond, was responsible for this fact. For example, Hamilton made it clear that under no political conditions would the United States' entry into the League of Armed Neutrality aimed against Britain be expedient. As such, some Americans saw the treaty as a trap artfully designed by the British and impudently accepted by Jay, who strove to be as accommodating as possible by seeking only peace. At the end of the negotiations, Jay wrote, ". . . may the hatchet be henceforth buried for ever, and with it all the animosities which sharpened, and which threatened to redden it." If he thought this to be the outcome of his efforts, the year 1812 was a staggering disappointment.

### JEWISH LIFE IN EARLY MIAMI 1896-1906

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A study of the beginnings of Jewish life in Miami is especially important because there are few, if any, instances among other American cities where Jewish people were present at the incorporation of a community and pioneered in its growth and development. Miami's modern or incorporated era began in 1896 with the coming of the Florida East Coast Railroad. Although few in number (originally 12, in 1896) and faced with life in a rough frontier community, early Jewish pioneers of the area always tried to maintain religious services. By 1899 only three of the original Jewish pioneers remained--Mrs. Frank, Isidor Cohen and Jacob Schneidman. Jewish people of Miami suffered little disadvantage because of their religion during the first ten years of Miami's history. Although there were as many as twenty-two Jews in the community during Miami's early days, only one was to participate actively in local civic and political affairs. Isidor Cohen projected himself into local politics immediately after his arrival in Miami. Civic affairs played an increasingly important part in his life, especially after 1903. By the time of his death in 1951 he had been secretary of the first Community Chest, secretary of the American Red Cross, a member of the State Democratic Executive Committee and a member of the charter board that drew up the city manager form of government used by Miami for many years. In

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addition, he was one of the organizers of Temple Beth David, oldest Jewish congregation in the Miami area. Isidor Cohen, for many, Jew and non-Jew, became "the" Jew of early Miami. However, it was during the second decade of the century that the Jewish population of Miami began to grow. The initial stage of Jewish development was consummated.

### LEGISLATOR PERCEPTION OF EDUCATIONAL NEEDS AND EDUCATIONAL POLICY MAKING

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A major purpose of this study was to determine what perceptions Virginia legislators had regarding educational needs and educational policy making in the Commonwealth of Virginia. A second purpose of this study was to determine whether regional differences existed in the Commonwealth of Virginia with respect to legislator perceptions regarding educational needs and educational policy making. A third purpose of this study was to determine if legislator biographical variables and legislator congressional district domicile group demographic variables correlated with legislator responses regarding their perceptions.

The population investigated in this study was the membership of the 1975 Virginia General Assembly. All senators and delegates were included as subjects. The number of useable responses was 103, or 74 percent of the population. For purposes of determining whether differences existed in legislator perception on a regional basis, these legislator respondents were assigned to groups according to their residency in the ten U.S. Congressional Districts in Virginia. Two procedures were used in collecting data for this study. Through the use of the survey, data were collected regarding legislator perceptions of educational needs and educational policy making. Additional information regarding legislator biographical variables and legislator congressional district domicile group demographic variables was collected through the use of state and federal public documents.

The data were analyzed in two different ways. Findings with respect to individual legislator perception and perceptions were reported descriptively in terms of response to all items on the questionnaire. Additionally, correlations between legislator questionnaire responses and a selection of biographical and demographical variables were reported. The alpha level selected for determination of statistical significance was  $p = <.05$ .

No great differences in legislator response, in general, existed with respect to most of the perceptions regarding educational needs and educational policy making. While legislators perceived educational needs of the Commonwealth to be of a major priority and while they considered themselves to have as much educational expertise as other legislators, most did not reply to the question regarding a solution which

would best satisfy the educational needs of the Commonwealth. Additionally, the legislators were satisfied to maintain taxes as they were for educational needs.

Response variance among Congressional District groups was not eminent. Those perceptions having the most significant response difference among district groups were related to legislator opinions regarding a choice of solutions which would satisfy most educational needs of the Commonwealth; educational expertise of constituents when compared to educational expertise of legislators; the engagement of Virginia public school teachers in collective bargaining procedures; the value of the Standards of Quality in helping improve education in home districts; educational lobby effectiveness; and educational lobby influence on the accuracy of legislator opinion regarding educational needs.

Of the twenty legislator perceptions investigated, ten were significantly related to at least one of the selected biographical/demographic variables employed in the study. The variable of respondent age had a statistically significant positive relationship with the legislator perceptions of agreement with party position; constituent educational expertise; the value of the Standards of Quality; and educational lobby influence on legislator needs perceptions. The variable of respondent education level had a statistically significant positive relationship with the legislator perceptions of personal educational expertise, and the degree of Commonwealth taxation for education. This variable had a statistically significant negative relationship with the perception of constituent educational expertise. The district degree of urbanization had a statistically significant negative relationship with the legislator perception of educational expertise of Education Committee members. No apparent pattern was noted among the significant correlations.

The findings of this study may be utilized by a variety of people. Educational planners at the state level, for example, might use them as guidelines in their dealings with General Assembly members. Planners could explore with the legislators the topic of why a majority of the study respondents did not select any solution offered on the questionnaire to satisfy most of the state's educational needs. Additionally, lobbyists might employ findings related to the amount of legislator regard for Education Committee member expertise reported by the respondents. Constituent-parents might use data related to fiscal issues and teachers might use data related to the collective bargaining issue to generate discussion with legislators, especially during election periods. Legislators, themselves, might use this data in determining budgetary policies and party strategies.

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### THE AMERICAN PRESS AND THE JAPANESE SUBJUGATION OF KOREA 1894-1905

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During the Russo-Japanese War of 1904-1905 Japan took control of Korea, formally annexing her on August 22, 1910. She did not relinquish control until forced to at the conclusion of the Second World War in 1945. But the United States had both the most extensive holdings and the most nationals of any western government in Korea for a ten-year period before the Russo-Japanese War. In addition, the United States was instrumental in maintaining Korean independence during this period. The American government, however, was not interested in exploiting this advantage for a number of reasons.

The American people generally pride themselves on being well-informed on international matters. Unfortunately, the American public was completely unaware of the situation in Korea from 1894 to 1905. They knew only that Korea was involved in two wars: the Sino-Japanese War of 1894 and the Russo-Japanese War of 1904-1905. They did not know why these conflicts had occurred, who were the aggressor nations, or the extent of America's involvement in Korea. There are two reasons why the American people were unaware--the complete failure of the American press to perceive the economic, political and social life of the East, and the pro-Japanese bias of the presidential administrations from the opening of Japan in 1853 until the final phases of the Russo-Japanese War, coupled with the United States State Department's repression of both printed and oral expressions by American nationals in Korea and the Department's representatives at its Seoul legation. But the reason the American people were not aware of the situation in Korea is primarily the responsibility of the American press, for this press molded and set American public opinion.

### THE FAILURE OF CONCILIATORY DIPLOMACY: A SURVEY OF THE CAREER OF DON BERNARDINO DE MENDOZA IN ENGLAND

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In 1570 Pope Pius V excommunicated Queen Elizabeth of England and began urging the undertaking of the "Enterprise of England." By this scheme Catholic forces would invade England, placing the Catholic Mary Stuart on the throne. The pope looked to Philip II of Spain, the most powerful of his coreligionists in terms of influence and resources, as the natural leader of such an invasion. Philip, however, plagued by rebellion in the Netherlands and fearful of French domination in England should Mary become queen, withstood papal pressure until 1588. In the

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meanwhile, he made serious attempts to keep peace with England, the last of which was the reopening of the Spanish embassy in London (1578) with Don Bernardino de Mendoza as resident ambassador. Though Mendoza's initial instructions were to placate Elizabeth, by 1581 he was conspiring against her with disaffected English and Scottish Catholics. In 1584 Mendoza was expelled from England for complicity in the Throgmorton conspiracy. The post he vacated was not filled again until after Philip's death. This study recounts Mendoza's mission in England, focusing on the causes of the abandonment of conciliation and tracing the growth of the Throgmorton plot.

## HEALTH SCIENCES

### ALTERATIONS IN PIG PLATELETS AFTER A SHOCK-INDUCING PROCEDURE

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Blood platelets are thought to be involved in much of the tissue damage in shock, or low flow, states. The involvement may occur for several reasons: (1) platelets release a number of vasoactive compounds (e.g. serotonin, prostaglandins (PG), endoperoxides (EP), and thromboxanes (Tx)) which may contribute to continuance of low flow by virtue of vasoconstriction, and (2) platelets may respond to other compounds or exposed surfaces with formation of aggregates, which can then lodge in the microcirculation of, e.g., lung, and thus promote continuance of low flow and its damage. We have thus examined the aggregation responses of platelets from splanchnic artery occlusion shock pigs and compared them with responses from sham shocked pigs.

Platelet rich plasma (PRP) was prepared from freshly drawn citrated whole pig blood by low speed (500 rpm) room temperature centrifugation for 15 minutes. After removal of the PRP, the plasma was again centrifuged (5000 rpm, room temperature, 45 minutes) to prepare platelet poor plasma. Response of the platelets to stimuli was followed by recording light transmission changes with time (aggregometry), using a Payton dual channel instrument (PRP = 0%, PPP = 100%). Stimulation by ADP, added in 5  $\mu$ l to a 500  $\mu$ l PRP sample, was determined at multiple ADP concentrations, and the maximum response and initial slope of the aggregation curve calculated as percent of pre-treatment control for each animal at each concentration; the data were averaged within groups.

We find that there is no significant difference between platelet responses in the sham shocked animals, for either maximums or initial slopes. However, there are definite decreases in both for the true shock animals. These decreases were significant at the  $P \leq .05$  level

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for 5, 2.5, and 1.25  $\mu\text{M}$  ADP for the maximum, and for 100, 2.5 and 1.25  $\mu\text{M}$  ADP for initial slope. There were no significant differences in the number of circulating platelets, or size, for either group. Decreases in reactivity may be the result of prior exposure to stimulating agents, rendering the platelets relatively non-reactive for a period of time. The discrepancy between our data and that of others who report increases in reactivity may be due to differences in time of sampling after release of the occlusion, which here was very early (15 minutes), and also to utilization of different species. Similar explanation for the lack of decrease in numbers of platelets is also given.

### THE DIFFERENCE IN PHYSIOLOGICAL EFFECTS BETWEEN ARM AND LEG EXERCISE

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Measurements of heart rate (HR), oxygen utilization ( $\dot{V}\text{O}_2$ ), and carbon dioxide production ( $\dot{V}\text{CO}_2$ ) as a function of load were made on seven normal physical education graduate students during both arm and leg exercise. The mean values of these metabolic parameters plus the respiratory quotient ( $\text{RQ} = \dot{V}\text{CO}_2/\dot{V}\text{O}_2$ ) and the oxygen pulse ( $\text{OP} = \dot{V}\text{O}_2/\text{HR}$ ) are presented in tabular and graphical form to show how the metabolic demands of arm exercise increase much more rapidly than the metabolic demands of leg exercise. However, the fact that all these metabolic parameters plateau for arm exercise at maxima which are well below the maxima for leg exercise indicates that arm exercise alone does not fully utilize the cardiopulmonary capacity of the body. It is speculated that there is some critical muscle mass, greater than the mass of the upper torso muscles brought into play during arm exercise alone, which must be utilized in order to fully tax the cardiopulmonary capacity of a normal, healthy individual. (D. Boatwright, B. Carr, S. Dodd, E. Roberts, C. Rosemond, and K. Winther cooperated in the data collection and analysis.)

### NERVE FIBER SIZE SPECTRUM AND ELECTROPHYSIOLOGY IN THE BRAINSTEM AUDITORY PATHWAY

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Fiber diameter distribution of the trapezoid body (TB) in the rat was studied. Brainstem tissues were fixed with 1% formaldehyde and 1.25% glutaraldehyde and subsequently with 4% formaldehyde and 5% glutaraldehyde and embedded in EPON. Semi-thin sections of 1 micron thickness were stained with toluidine blue and examined under light microscope. Recordings of single neurons were also carried out in the



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cochlear nucleus (CN) and the superior olivary complex (SOC). Results are (1) The fiber size spectrum of TB was bimodal. (2) TB was organized into 3 layers, a. ventral small fiber layer, b. intermediate mixed fiber layer, and c. dorsal small fiber layer. (3) Short-latency single cells in the CN and SOC were recorded but the latency distribution did not appear to be bimodal. The implications of these results will be discussed.

### ANTIEPILEPSY DRUGS: INTERACTIONS WITH BRAIN CYCLIC NUCLEOTIDES

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Adenylate cyclase functions as a postsynaptic receptor within the central nervous system and may be involved in the mediation of specific types of neurotransmission- and depolarization-induced events. This suggests a relationship between the enzyme and the relative instability seen with respect to neurons within epileptogenic foci. The investigation was designed to determine whether different classes of antiepilepsy drugs might act via a common molecular pathway to influence the adenylate cyclase-cyclic AMP system within the brain. Two approaches were employed. The first utilized incubated tissue slices of the cerebral cortex *in vitro* to test the action of the drugs on cyclic AMP accumulation elicited by norepinephrine, adenosine, ouabain and KCl. In this study carbamazepine > phenobarbital > phenytoin toward the action of norepinephrine, while phenobarbital > carbamazepine > phenytoin acted to inhibit the adenosine response. Similarly, the effects of ouabain were antagonized by carbamazepine, phenytoin > clonazepam > phenobarbital. The action of KCl was not inhibited by the drugs. Diazepam and clonazepam elevated basal levels of cyclic AMP. The second study involved pre-injections of the anticonvulsants followed by administration of a convulsant agent (pentylenetetrazol) 1 hr. later, with sacrifice occurring within 5 min. thereafter using focussed microwave irradiation, and ultimate measurement of brain cyclic AMP content. Injections of pentylenetetrazol alone increased the steady-state content of cyclic AMP in the cerebral cortex and the cerebellum. Preinjection of the anticonvulsants prevented for the most part both the convulsant action of and the elevation of cyclic AMP by pentylenetetrazol. (Supported by a grant from the Epilepsy Foundation of America.)

### THE EFFECTS OF TACTILE STIMULATION ON MUSCLE RELAXATION IN THE IRRITABLE NEONATE

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The primary and most fundamental method of human communication occurs through some form of touch. Tactile experiences initially shape



the neonate's perceptions of the world around him. Furthermore, the individual's early experiences with touch affect his later growth and development. Denial of tactile stimulation can impair the infant's future ability for learning, intimacy, and affection.

The element of touch is a critical experience in alleviating pain and discomfort of the neonate. Manual massage can be utilized to achieve relaxation of the voluntary muscles. Unfortunately, many caretakers seek to relieve their infant's discomfort through mechanical means, i.e., the pacifier, without first employing methods that incorporate tactile stimuli. The purpose of the study was to determine the effects of tactile stimulation on muscle relaxation in the irritable neonate.

A sample of twenty neonates, each serving as his own control, were utilized in two research sessions. The intervention session consisted of tactile stimulation (massage) while the non-intervention session consisted of observation only. The infant's relaxation state was directly correlated with changes in muscular activity. The change in muscular activity was denoted by an increase or decrease in action potentials of the neonate's frontalis muscle. The action potentials were measured by electromyograph recordings.

The findings of the research sessions were compared statistically by a two-tailed t-test for matched pairs. The results supported the idea that tactile stimulation can achieve muscle relaxation in the irritable neonate. The study, therefore, discloses that touch can be an effective means of soothing irritable infants.

### STUDIES OF NEUROACTIVE AGENTS BY ANALYSIS OF THE ELECTROENCEPHALOGRAM

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Many studies have described methods for extracting data from the EEG of experimental subjects. This report describes an analytical method and some typical results obtained from its application to studies of the effects of a convulsant ( $\gamma$ -hydroxybutyric acid), and anticonvulsant (clonazepam) and an endogenous hallucinogen (N,N'-dimethyltryptamine) on the EEG of laboratory animals. The EEG from rodents implanted with unipolar cortical electrodes was amplified, recorded graphically and passed into a zero crossing detector. Such preprocessing permitted a digital frequency band analysis to be performed on-line by a minicomputer. Frequency band analysis data was output from the minicomputer on paper tape and then formatted and plotted through the use of a programmable calculator interfaced with an X-Y plotter.

Rats given  $\gamma$ -hydroxybutyrate (300  $\mu$ g/g, i.p.) were found to exhibit increased electrical activity in the 2-5 Hz band. This increase in 2-5

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Hz activity could be observed within five minutes after administering the convulsant, and reached maximum intensity within an additional 10 minutes. This increased low frequency activity induced by  $\gamma$ -hydroxybutyrate was antagonized by clonazepam (1  $\mu$ g/g, i.p.). When mice were given 0, 10 or 20  $\mu$ g dimethyltryptamine/g i.p., there was no detectable abnormal shift in the EEG frequency bands studied (i.e. the 0.5-2 Hz, 2-5 Hz, 5-8 Hz, 8-12 Hz, 12-15 Hz, 15-25 Hz). However, peaks in the 5-8 Hz band were found to coincide with episodes of rapid eye movement sleep. Dimethyltryptamine (at 20  $\mu$ g/g) produced a generalized alerting effect in mice. The frequency band analysis utilized seems to offer the advantages of simplicity and speed for studies of the time course effects of neuroactive agents on the EEG.

### SUPPRESSION OF AMPHETAMINE-INDUCED CIRCLING IN RATS WITH SUBSTANTIA-NIGRAL LESIONS

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It has been shown that following unilateral lesions of the substantia nigra, rats will turn to the side of the lesion when they are given amphetamine. One of the ways in which amphetamine acts is by releasing pre-synaptic stores of dopamine and norepinephrine. L-valine has been reported to block the hypothermic response of rats given amphetamine and placed in a 4°C environment. The present study was carried out to study the effects of L-valine on rats with unilateral substantia nigral lesions and administered various doses of amphetamine. Adult, male Long-Evans rats were anesthetized and placed in a rat stereotaxic and electrolytically lesioned in the right substantia nigra. After recovering from surgery the rats were tested with amphetamine at 2, 4 or 6 mg/kg either singly or 30 minutes after 250 mg/kg L-valine. The number of turns, to the left or right, made during one minute were recorded at 0, 15, 30, 45 and 60 minutes after the administration of amphetamine. Amphetamine induced marked turning to the side of the lesion, which was suppressed by the pre-treatment with L-valine. The mode of action of this suppression is thought to be via the lowering of brain tyrosine levels.

This study was supported in part by funds from the Alabama Consumer Fund.

EFFECTS OF RAPHE LESIONS ON CONDITIONED AVERSIONS IN THE RAT

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If an animal becomes ill following the ingestion of a novel substance, intake of that substance will be diminished on subsequent presentations. This phenomenon is known as conditioned taste aversion (CTA). Lesions in many areas of the brain have been shown to impair CTA learning. Recently, however, research has suggested that electrolytic and chemical (5,7-dihydroxytryptamine) lesions in the area of the raphe nuclei which result in substantial depletions of forebrain serotonin enhance the learned suppression of drinking a novel fluid paired with toxicosis. Many drugs can be used to produce CTA's. Enhancement of CTA learning by serotonin depletion has been investigated only with lithium chloride as the aversion-inducing agent. The generality of the effect has not been studied.

The experiment reported here examined the effects of midbrain raphe lesions on the development of CTA's induced by injections of fenfluramine, an anorexic agent which has been shown to be effective in the CTA paradigm. Previous research has demonstrated that fenfluramine can cause damage to midbrain raphe neurons and that the anorexic properties of the compound depend on the integrity of these midbrain serotonergic neurons. It is possible that the effectiveness of fenfluramine in the CTA paradigm is due to its action on central serotonergic neurons. If so, raphe lesions would be expected to impair rather than enhance fenfluramine induced CTA's. The data from this experiment show that lesions of the raphe nuclei, which deplete telencephalic serotonin, enhance CTA's produced by fenfluramine. This suggests that while serotonergic mechanisms may play a role in the development of CTA's induced by fenfluramine, these mechanisms are not necessary for the development of taste aversions induced by either lithium chloride or fenfluramine.

EFFECTS OF MIDBRAIN LESIONS ON THE NICOTINIC  
ACETYLCHOLINE RECEPTOR IN RAT BRAIN

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The snake venom protein  $\alpha$ -bungarotoxin binds with specificity and high affinity to nicotinic acetylcholine receptors (nAChR) of striated muscle, the electric organ of certain fish, and mammalian brain.  $^{125}\text{I}$  tagged  $\alpha$ -bungarotoxin was used to evaluate the effects of midbrain lesions on nAChR concentrations in rat brain. In the periphery, denervation has been shown to cause large increases in extrajunctional receptor concentrations. Previous experiments have failed to detect lesion

induced increases in muscarinic cholinergic receptor binding in brain. This was the first attempt to evaluate the effects of central nervous system lesions on nAChR concentration in brain. It was found that lesions in the area of the raphe nuclei produced an increase in nAChR concentration in the olfactory bulbs. The increase in olfactory bulb nAChR after midbrain lesions implies a direct cholinergic projection from the midbrain to the olfactory bulbs. Previous anatomical investigations utilizing autoradiography and horseradish peroxidase histochemistry have demonstrated direct projections from the dorsal raphe nucleus to the olfactory bulbs. These projections were assumed to be serotonergic, based on the high concentration of serotonergic cell bodies in the dorsal raphe. The dorsal raphe does, however, show light staining for acetylcholinesterase. The increased nAChR concentration in the olfactory bulbs due to midbrain lesions suggest that perhaps some of these projections from the dorsal raphe are cholinergic rather than serotonergic. No comparable increases in nAChR concentrations were found in other brain areas examined. These included the hypothalamus, hippocampus, and cortex, regions known to receive serotonergic projections from the raphe nuclei.

### THE ROLE OF PHOSPHOLIPIDS IN THE SUBSTRATE-INHIBITOR SPECIFICITIES OF THE MULTIPLE FORMS OF MONOAMINE OXIDASE

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Substrate-inhibitor specificities of the multiple forms of monoamine oxidase (MAO) may depend in part on the chemical structure of the bound membrane lipids. Treatment of the enzyme(s), both MAO-membrane and purified MAO-A type preparations, with phospholipase A from *Naja naja* venom removed almost all phosphatides with concomitant loss of both MAO-A and MAO-B type activities at three different assaying temperatures. Digestion with phospholipase C from *Cl. Welchii* attached mainly on phosphatidylcholine, sphingomyelin and phosphatidylethanolamine but none of phosphatidylserine or cardiolipin. MAO-A type activity was almost abolished whereas MAO-B type activity was greatly enhanced by phospholipase C treatment. On the other hand, digestion with phospholipase D from cabbage hydrolyzed phosphatidylcholine, phosphatidylethanolamine and phosphatidylserine. MAO-B activity was depressed and MAO-A activity was stimulated moderately. It was concluded that phosphatidylserine and cardiolipin are required for MAO-B enzyme, whereas sphingomyelin but not phosphatidylserine is specific to MAO-A enzyme. Phosphatidylcholine and phosphatidylethanolamine were found to have little or no effect.

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### ACARDIA, ANENCEPHALY, AND OTHER DEFECTS IN A HUMAN FETUS

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A case of an acardius acephalus fetus is reported. One digit is absent from each hand. Two digits are lacking from the right foot and one from the left foot. The thoracic viscera are absent. The aorta bifurcates into two innominate arteries, each of which gives rise to a carotid artery and a subclavian artery. The divisions of the alimentary canal and other abdominal organs are grossly identifiable except the liver, pancreas, and spleen. The entire spinal cord and a short cephalic extension of the cervical cord designated as "the medulla" represent the brain. The brachial plexus and the lumbar plexus appear normal. Microscopically, some of the tracts and nuclei are present in the cord. The "medulla" lacks recognizable areas. Although clumps of cells and strands of fibers are evident, there is no organized pattern. Microscopic structures of all tissues appear to be normal except some of the nerve tissue.

### NICHE--A COMMUNITY SERVICE FOCUSED ON HEALTH AND HEALTH EDUCATION

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NICHE--Nurses Involved in the Community for Health Evaluation and Education--is a health facility jointly sponsored by the University of Alabama School of Nursing at UAB and two churches in a suburban community south of Birmingham for the purpose of providing that community with an alternative in health care.

Nursing clinics are not new--what is new is for these services to be offered to an upper middle income population who utilize private medical care for health care.

Health care as practiced and defined by NICHE is: health evaluation and health education to guide the individual and the family in maintaining their highest degree of physical and emotional well being, and the early detection of medical problems with prompt consultation and referral.

NICHE is staffed by nurses educationally prepared to provide health care in ambulatory settings. Services include a comprehensive family history, selected laboratory tests, hearing and vision screening, and physical examination. Problems are identified, appropriate counseling is done and management is mutually planned by the client and the nurse.

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Concerns about success of the NICHE project centered around: 1) patient acceptance, 2) quality of care, and 3) maintenance of the patient/doctor relationship.

NICHE is providing a dimension of health care which this population has not received from other sources. The question yet to be answered is, "Does the service NICHE provides make a difference in the health status of the individuals and families who utilize this alternative?"

### THE PELLAGRA STORY IN ALABAMA

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The story of pellagra in the United States began at the Mount Vernon Hospital which was a branch of the Bryce Hospital for the mentally ill at Tuscaloosa. Dr. George H. Searcy observed an epidemic of pellagra in 1906 in his ward which contained 88 patients. As soon as he determined the nature of the disease he took all of them off a diet of corn bread and grits and substituted white bread and potatoes.

Then Dr. Searcy put eight patients on the original diet which had produced pellagra. One of the patients developed pellagra and the other seven patients were in such poor health that he changed their diets. This was the first experimental production of pellagra. None of the nurses had pellagra since their diets were different from the diets given to the original patients. The results were published in *Trans. Med. Assn. State of Ala.* 1907. The complete paper was also published in the *J. Am. Med. Assn.* July 6, 1907.

The Federal Government conducted a lawsuit against the Coca Cola Company for adding caffeine to their syrup at Chattanooga, Tennessee in 1911. Dr. H. W. Wiley, Chief of the Bureau of Chemistry, was the leader in the suit. The federal government had ten scientists who testified that Coca Cola was harmful while the company had fifteen nationally recognized chemists and biological scientists who were for the defense. Judge E. T. Sanford was in charge of the federal court. The company won and the judge advised that in the future the government should be certain of evidence. It is the thesis of this author that the Coca Cola trial had a definite bearing on the pellagra story.

The U.S. Public Health Service took the advice of Judge Sanford. Dr. Joseph Goldberger earned the M.D. degree at Bellevue Hospital Medical College in 1895 and joined the USPHS in 1899. Goldberger planned studies on pellagra so that he would not fail to obtain results similar to those of Searcy. Goldberger obtained permission to experiment on convicts at the Mississippi Penitentiary Farm just east of Jackson, which was located at approximately the same latitude and longitude as is Mount Vernon. He fed eleven convicts on a diet of corn bread, wheat flour, rice, pork fat with some green vegetables and sweet potatoes from



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4 February to 1 November 1915. Six of the convicts developed pellagra while the controls on a different diet showed no signs of pellagra. He reported that the diet had a controlling influence on the prevention and causation of pellagra. In other words, Goldberger had confirmed Searcy's experimental production of pellagra. Goldberger continued to report on pellagra studies for the next twenty years but never referred in print to Searcy's publications. Also, USPHS investigators avoided mentioning Searcy in their published reports. Since Goldberger and his associates did confirm Searcy's research on pellagra but did not discover any new information, the Goldberger Award which was established by the AMA in 1949, and is controlled by the AMA, seems to have a bit of tarnish on it when the above facts are evaluated. If the award is continued, it seems logical to change the name to the Searcy-Goldberger Award.

### RECOVERY FROM SUBCUTANEOUS HERPES SIMPLEX VIRUS TYPE 2 INFECTION FOLLOWING PASSIVE TRANSFER OF SPECIFIC ANTIBODY

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Young adult mice infected with  $3 \times 10^6$  pfu of herpes simplex virus type 2 (HSV-2) died within 9-12 days following spread of virus from sites of infection to the spinal cord and brain. Administration of HSV-2 neutralizing antisera prepared in syngeneic mice, or in rabbits, inhibited spread of virus from the footpad of infected animals and prevented death. A single intraperitoneal inoculum of antiserum (virus neutralizing titer of 1:128) was effective in protecting mice when given 8 hours after virus inoculation. If the mice were given a sublethal dose of irradiation (390 R) 24 hrs. before antibody transfer, protection was no longer obtained. This suggested that the mechanism of protection probably was not solely due to *in vivo* neutralization of virus, but required the participation of a radio-sensitive component which has not yet been defined.

### SPECIFIC CYTOTOXICITY OF HERPES SIMPLEX VIRUS TYPE 1-SENSITIZED LYMPH NODE CELLS FOR VIRUS-INFECTED CELLS

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Immunization of hamsters with rabbit kidney-grown herpes simplex virus type 1 (HSV-1) resulted in the generation of lymphocytes from



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draining lymph nodes that were cytotoxic for HSV-1-infected syngeneic hamster embryo fibroblasts (HEF) in an 18-hour but not a 6-hour <sup>51</sup>chromium releast test. This cytotoxic activity was virus-specific since the HSV-1-immune effector cells did not react with uninfected HEF or HEF infected with vaccinia virus. The latter were readily lysed by homologous immune cells. Histocompatibility between target cells and effector cells was not obligatory as significant cytotoxicity was also observed against allogeneic and xenogeneic HSV-1-infected target cells. The effector cells did not appear to be adherent cells since passage through a nylon wool column did not diminish kill. However, treatment of the immune lymphocytes with rabbit anti-hamster gamma globulin serum plus complement or inclusion of cyclohexamide in the incubation medium decreased or abolished cytotoxic reactivity. The results suggest that the mechanism of killing was principally that of antibody-dependent cellular cytotoxicity.

### TREATMENT OF HERPES SIMPLEX VIRUS ENCEPHALITIS IN MICE WITH 5-ETHYL-2-DEOXYURIDINE

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Studies on the antiviral activity of the thymidine analog 5-ethyl-2-deoxyuridine (5-EDU) showed that the drug is virostatic for herpes simplex virus (HSV) types 1 and 2. The concentration of 5-EDU which gave 50% inhibition of plaque formation in Vero cells was in the range of 6 and 9 µg/ml for HSV-1 and HSV-2 respectively. The compound was not toxic for cells since at levels 14 fold in excess of the ED<sub>50</sub> for HSV-2 inhibition of Vero cell division was not observed.

*In vivo* work showed that following subcutaneous infection 5-EDU was effective in significantly increasing survival rates of HSV-2 nonimmunosuppressed SJL mice (60%) and mean survival times (4.8 days) for immunosuppressed animals. Determination of the level of virus in the central nervous system tissue of infected drug-treated animals showed that in the nonimmunosuppressed group virus was not present. Immunosuppressed animals treated with 5-EDU had virus present in the sciatic nerve, spinal cord, and brain but at significantly lower levels than untreated controls.

These results indicate that 5-EDU may be considered as a potential agent for treatment of systemic herpesvirus infection in humans; however, an uncompromised host defense mechanism must be present for manifestation of its full antiviral activity.

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### IN VITRO SYNTHESIS OF MAMMALIAN MESSENGER RNA

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An *in vitro* RNA synthesizing system has been developed in which the template chromatin has no detected endogenous RNA polymerizing enzymes and/or RNA fragments which fulfill criteria of an eukaryotic messenger RNA. The endogenous RNA polymerizing enzymes and nascent RNA have been removed from the rabbit marrow chromatin by treatment of purified chromatin solutions with buffered urea/guanidine hydrochloride. This treatment does not appear to affect the sizes of the relative amounts of the transcribed RNA products as determined by sucrose density gradient centrifugation. *De novo* transcript RNA can stimulate amino acid polymerization in the wheat germ *in vitro* protein synthesis system, and the kinetics of this activity suggest a requirement for post-transcriptional modification. A lag in the rate of amino acid polymerization is observed when the transcript RNA is translated. By contrast no lag is observed in the translation rate of cytoplasmic mRNA. (Supported by NIH grant GM-21243 and by intramural funds from the College of Medicine, University of South Alabama.)

### STERIOD INHIBITION OF CAT PANCREATIC cAMP PHOSPHODIESTERASE ACTIVITY

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Cellular changes in the pancreas play an important role in the pathophysiology of shock or low flow state. Since steroid administration increases survival time in shocked animals and maintains cyclic AMP (cAMP) levels in the ischemic pancreas, the inhibitory effect of steroids on cAMP phosphodiesterase (PDE) activity was studied in normal cat pancreas and liver.

Crude homogenates of cat pancreas and liver were incubated with or without steroid or theophylline and PDE activity was measured by conversion of cAMP to ATP.

At 400  $\mu$ M of substrate concentration methylprednisolone sodium succinate (MPSS) and hydrocortisone sodium succinate (HCSS) significantly inhibited PDE activity in both pancreatic and hepatic tissues in concentrations ranging from  $10^{-2}$  to  $10^{-4}$ M (5-100%). No significant differences in inhibitory activity of the two steroids were seen.

In order to obtain a Lineweaver-Burk plot, cat pancreatic tissues were incubated with 2mM of MPSS, 2mM of HCSS, 1mM of theophylline, and

with vehicle, respectively. In these incubations  $V_{max}$ s were 2.51, 2.59, 2.22 and 2.16 nmol cAMP hydrolyzed per mg of protein per min. and  $K_m$ s were 36.7, 16.5, 21.6 and 7.11  $\mu$ M, respectively. No significant differences were seen between the  $V_{max}$ s, however, significant differences were observed between  $K_m$ s. These results suggest that both MPSS and HCSS inhibit cat pancreatic PDE activity competitively.

A Dixon plot showed a pure competitive type of inhibition and a partially competitive type of inhibition. Three different substrate concentrations were employed in each inhibition study. The lines were all curved with MPSS or HCSS. Therefore, MPSS and HCSS appear to be partially competitive inhibitors of cat pancreatic cAMP PDE.

## A SIMPLE SOLID PHASE SYNTHESIS OF N<sup>3</sup>-METHYLTHYROTROPIN RELEASING HORMONE

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Pyroglutamyl-N<sup>3</sup>im-methylhistidylprolineamide (methyl-TRH) is a synthetic analog of the natural hormone (TRH) and has been found to be a more potent releaser of thyroid stimulating hormone (TSH) in the mouse bioassay. We recently reported that methyl-TRH is a more potent thyrotropin and prolactin releaser than TRH in euthyroid subjects.<sup>1</sup> The synthesis of methyl-TRH has been done by Rivier and coworkers by a solid phase procedure utilizing a benzhydrylamine resin, and HF cleavage, in about 30% yield.<sup>2</sup> In our laboratory, methyl-TRH was synthesized using the Merrifield chloromethyl resin and HBr cleavage by an analogous solid phase procedure which was originally developed for the synthesis of TRH.

t-Butyloxycarbonyl-L-proline resin ester (1.0 mmole of proline) was deprotected with 20% CF<sub>3</sub>COOH in CH<sub>2</sub>Cl<sub>2</sub> for 40 minutes, washed and neutralized. N<sup>3</sup>-methylhistidine was converted to the corresponding t-butyloxycarbonyl derivative by reacting with t-butyloxycarbonylazide and MgO and was isolated as the magnesium salt. Treatment of this salt with isobutylchloroformate in DMF in the presence of N-methylmorpholine gave the mixed anhydride which was coupled with the resin-bound proline to produce the resin-bound dipeptide. The untreated proline was protected at this stage by acetylation. The t-BOC-group of methylhistidine was then deprotected with CF<sub>3</sub>COOH. The mixed anhydride of L-pyroglutamic acid with isobutylchloroformate was reacted with the resin-bound dipeptide; and the product was cleaved from the resin by gaseous HBr in CF<sub>3</sub>COOH. The product was purified by Dowex-50 chromatography. The free carboxyl group of the tripeptide was then activated with isobutylchloroformate and the amide functionality was introduced by its reaction with gaseous ammonia. Repurification was accomplished by chromatography on Dowex-50 using a linear HCl gradient. The NMR spectrum of the material was

identical to the reported spectrum and the compound showed the consistently higher levels of biological activity in several systems compared to the natural hormone.

<sup>1</sup>J. R. Sowers, J. M. Hershman, A. E. Pekary, M. G. Nair, and C. M. Baugh, *J. Clin. Endocrinol. Metab.* 43, 471 (1976).

<sup>2</sup>J. Rivier, W. Vale, M. Monahan, N. Ling, and R. Burgus, *J. Med. Chem.* 15, 479 (1972).

EXPONENTIAL GROWTH OF WEANLING RATS IN RESPONSE TO DAILY  
INTAKES OF LABORATORY CHOW ALLOCATED ACCORDING  
TO FIXED INTAKE/WEIGHT RATIOS

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Parks (*J. Theor. Biol.* 55: 371, 380, 1975) has proposed that the dynamics of growth can be described by the differential equation:

$$dW/dt = k_s (dI/dt) = k_d W \quad (1)$$

where  $dW/dt$  is the rate of weight gain,  $dI/dt$  is the rate of nutrient intake,  $W$  is body weight,  $k_s$  is a unitless efficiency constant and  $k_d$  is a decay constant with units of inverse time. The applicability of equation (1) to short-term growth studies was tested by feeding weanling male rats daily rations of a standard laboratory chow in proportion to body weight (i.e.,  $dI/dt$  was maintained proportional to  $W$ ). Equation (1) predicts that animals subjected to the foregoing constraint will either gain or lose weight exponentially with respect to time. This prediction was tested in a three-week experiment involving nine groups of rats containing six individuals per group. Intake levels for each group varied from 0-16% with increments of 2%. Upon initiation of proportional feeding and following a lag phase of 4-5 days, each group entered into a period of exponential weight change as predicted by the model. (Supported by a grant from the South Alabama Chapter of the Arthritis Foundation and by an intramural grant from the University of South Alabama.)

SUBCELLULAR PROTEIN DEGRADATION IN  
VARIOUS TISSUES OF AGED RATS

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A double-isotope labeling technique has been used to evaluate relative rates of protein turnover in subcellular fractions of liver, kidney

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and heart tissue during aging of the male Fischer 344 rat. The cellular fractions investigated included mitochondrial, microsomal and lysosomal proteins as well as soluble cytoplasmic proteins. No significant alterations in half-life were observed in any fraction obtained from kidney throughout the lifespan of the Fischer 344 rat. In liver, statistically significant ( $p < 0.01$ ) increases in half-life were observed for mitochondrial and microsomal proteins, but not for lysosomal and cytoplasmic proteins. These differences were observed to occur between young (9-12 mo.) and middle-aged (24 mo.) animals; no further reduction in turnover rates occurred between 24 and 34 months of age. Similar age-related decreases in turnover rates were observed with microsomal and mitochondrial proteins of heart tissue. However, the physiological significance of these results was obscured by a slow rate of turnover of heart proteins which approached the theoretical limit of the methodology employed.

### A STUDY OF THE METABOLISM OF GENTIAN VIOLET AFTER ORAL ADMINISTRATION

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This work studied the possibility of metabolism of gentian violet when fed orally to chickens.

Blood was analyzed spectrophotometrically for increased methemoglobin levels as an indication of absorption of gentian violet. Analysis showed no increase in methemoglobin levels thus the probability of no absorption.

Daily collection of excreta indicated the gentian violet administered was also being excreted. On sacrifice it was observed that there was staining of the gastrointestinal tract by gentian violet 48 hours after administration.

Spectrophotometric analysis of excreta indicated only 11.75% of the dose was recovered. All gentian violet was not being extracted from the excreta as evidenced by the violet color of the residue remaining after filtration.

The position of maximum absorbance of gentian violet was not affected in the pH range of 2.5-6.8. Above pH 7 carbinol formation occurs and below pH 1 there is a decrease in the spread of resonance.

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*In vitro* study of gentian violet, incubated with control excreta at pH 4.5, the average pH of the first portion of the gastrointestinal tract, and at 41°C, normal body temperature of the chicken, produced the same results as seen *in vivo*.

Thin layer chromatographic analysis of excreta extract did not detect any metabolites. When samples of excreta extract were overspotted with gentian violet standard, the corresponding components increased in size indicating no change occurred in gentian violet fed.

The evidence indicated that gentian violet was not absorbed or metabolized when fed orally to chickens.

### A CYTOLOGICAL AND ULTRASTRUCTURAL STUDY OF THE PIGMENT EPITHELIUM OF THE OPOSSUM EYE (*Didelphis virginiana*)

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The retinal tapetum of the common opossum is responsible for the phenomenon of eyeshine in this species and was first described by Walls (1939). To further elucidate the cytological features responsible for this phenomenon, retinas from 17 adult opossums were studied by modern techniques of histochemistry and transmission and scanning electron microscopy (TEM and SEM).

Histochemical results showed that the supranuclear regions of tapetal cells were filled with cholesterol-rich, reflecting spheres. By SEM, the average diameter of the spheres was found to be about 0.4  $\mu\text{m}$ ; the cells were 70  $\mu\text{m}$  in length. TEM revealed that the genesis of the spheres was associated with the smooth endoplasmic reticulum and mitochondria with tubular cristae located in the basal one-third of the cell. Apices of tapetal cells were lined by long microvilli which enmeshed the outer segments of the photoreceptor cells. Only rods were present in the tapetal area and their outer segments were nourished by microvilli of the tapetal cells since this portion of the retina was avascular. Extensive and highly specialized junctions with abundant microfilaments attached adjacent apices of tapetal cells and maintained the structural-functional relationship between tapetal and photoreceptor cells.

This study shows that the opossum can be included among animals with a retinal tapetum containing reflecting lipid spheres which are responsible for the phenomenon of eyeshine. It also appears that the opossum retina might be a good model to study cholesterol synthesis.



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### TRANSPORT AND ANTIFOLATE ACTIVITY OF ISOAMINOPTERIN

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The antifolate activity and the transport characteristics of isoaminopterin (IA) in HeLa cells were studied and compared to those of methotrexate (MTX). Both IA and MTX inhibited the incorporation of {2-<sup>14</sup>C}deoxyuridine into HeLa cell DNA by 50% at a concentration of 0.1  $\mu$ M. Unlike MTX, the inhibition of DNA synthesis by IA was time dependent and reached a maximum at 40 hours post-addition of the compound. IA induced inhibition of DNA synthesis was completely reversed by N<sup>5</sup> formyl tetrahydrofolate at a concentration of 100  $\mu$ M. At this concentration, 40% of the DNA synthesis was restored in MTX treated cells. These results indicate that IA induced inhibition of DNA synthesis is due to interference with folate metabolism rather than toxicity by other mechanisms. Competitive transport experiments between IA and either radio-labeled MTX or folate showed that IA preferentially uses the reduced folate/MTX transport system. Comparison of the ID<sub>50</sub> values of MTX transport by IA (8.6  $\mu$ M) and two other classical analogs of aminopterin, 10-oxaaminopterin (0.74  $\mu$ M) and 10-thioaminopterin (2.7  $\mu$ M) indicate that IA is transported into the cells with a lesser affinity than MTX and this may be responsible for the time dependent effect of IA on HeLa cell DNA synthesis.

### OVARIAN UTERINE TRANSPLANTATION: A MODEL FOR STUDYING TUBAL FUNCTION IN THE BABOON

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Five healthy female baboons with histories of normal ovulating menstrual cycles were subjected to surgical procedures in which both oviducts and one ovary were removed. The remaining ovary was transplanted into the fundrus of the uterus in a position that would allow eggs to be released directly into the uterine lumen. The hilus of the ovary and its attachment to the broader ligament was left intact in order to preserve normal ovarian blood circulation. Function of the transplanted ovary was evaluated by observing the daily cyclic changes in sex skin turgescence and color and by the determination of normal blood values for estrogen and progesterone by radioimmunoassay. The females were placed with the males for eight hours daily throughout the period of maximum sex skin turgescence (i.e., ovulator phase of the menstrual cycle) for mating. Normal cyclic ovarian function continued in all five baboons in which the surgical procedure was performed. This was evident from the finding that the surgical procedure had no discernable effect



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on: the cyclic changes in the sex skin turgescence; the length of the menstrual cycles; the pattern of menstrual bleeding; the behavioral response of the female and male at the time of mating; or the blood levels of estradiol and progesterone. Fertility was evaluated over an 18-month period during 62 separate menstrual cycles in which copulation was confirmed; no pregnancies resulted.

### COMBINATION OF STIMULI TO OBTAIN INCREASED ACID SECRETION RATES USING *RANA PIPIENS* GASTRIC MUCOSA *IN VITRO*

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The average published *in vitro* acid secretion rate for *Rana pipiens* is approximately 4  $\mu\text{Eq/hr cm}^2$ . This rate is only a small percentage of the maximum rate that can be obtained *in vivo*. The objective of this project was to establish *in vitro* conditions that would allow an isolated gastric mucosa to achieve secretion rates approaching those obtained *in vivo*. A combination of histamine ( $10^{-4}$  M), butyrate (5 mM), dibutyryl cAMP (5 mM) and aminophylline (10 mM) was added simultaneously to the nutrient (serosal) bathing solutions in the presence of 95%  $\text{O}_2$ -5%  $\text{CO}_2$  which elicited an increased response. By altering the gas concentrations to 90%  $\text{O}_2$ -10%  $\text{CO}_2$  an additional significant increase in rate was observed. Along with the stimulation of acid secretion rate there was a decline both in transmucosal PD and in tissue electrical resistance. Initially, varying concentrations of pentagastrin and serotonin were added along with those stimuli listed above, but after experimentation were found to elicit no additional response. The secretory rate could be inhibited by 10 mM  $\text{SCN}^-$  when added to either nutrient or secretory solutions. This inhibition occurred within 8 min after  $\text{SCN}^-$  addition, and was accompanied by an increase both in PD and in tissue resistance. Rates of secretion could also be inhibited by either DNP or anoxia. Metiamide ( $10^{-2}$  M), an  $\text{H}_2$  inhibitor, reduced the rate by 80%. We feel that by obtaining *in vitro* acid secretion rates approaching *in vivo* rate the parameters set forth here more closely model a physiological preparation. (NSF support)

### CARBOHYDRATE AND ION REQUIREMENTS FOR PHOSPHATIDYLINOSITOL HYDROLYSIS ( $\text{PiH}$ ) DURING THE FIRST PHASE OF INSULIN SECRETION

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Since a rapid breakdown of islet phosphatidylinositol accompanies carbohydrate-stimulated insulin release (IR) from the isolated rat pancreatic islet, we have studied the carbohydrate and ionic requirements

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for PiH during the first phase of insulin secretion. Using a novel incubation system, batches of 20 islets were incubated with 2-<sup>3</sup>H-myoinositol for 60 minutes, repeatedly washed, exposed to the test substances for 10 minutes and IR and PiH determined. When glucose was the stimulant, recovery of lipid-bound radioactivity was inversely related to IR ( $r = 0.94$ ,  $p < 0.001$ ). Those carbohydrates which stimulated IR (D-glucose, D-mannose, D-glucuronolactone, and D,L-glyceraldehyde) also caused PiH. Non-stimulatory carbohydrates (myoinositol, L-glucose, D-fructose, D-galactose, D-ribose, and pyruvate) did not cause PiH. Tolbutamide, ouabain and isoproterenol provoked both IR and PiH. In contrast, amino acid secretagogues (leucine, isoleucine,  $\alpha$ -ketoisocaproate) did not cause PiH. Extracellular  $Ca^{++}$  was required for both IR and PiH and equimolar replacement of  $Ca^{++}$  and  $Ni^{++}$  blocked both processes. Elevation of cytosolic  $[Ca^{++}]$  by ionophores caused IR without concomitant PiH. Elevation of cytosolic  $[Na^+]$  with ouabain or veratridine provoked  $Ca^{++}$ -dependent IR and PiH. We conclude that the PiH associated with carbohydrate-stimulated IR is the consequence of either reverse  $Na^+-Ca^{++}$  exchange, an increase in the concentration of a glycolytic intermediate (between the trioses and pyruvate) or a combination of these two phenomena.

## ISSUES IN HUMAN SUBJECTS' USE IN NURSING RESEARCH

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In the last few years, guidelines and approvals necessary for research involving human subjects have become increasingly strict. Nursing research, because of its clinical nature, involves use of human subjects and many safeguards for the protection of those subjects' rights are incorporated into research protocols.

Assessment of risk is of primary consideration. In nursing research the actual induced risk of interventions is usually very low, but significant potential psychological risk is often present. For example, a simple procedure such as administering a questionnaire to new parents may introduce doubts in their mind as to their own or their baby's well-being. Such risks must be carefully and professionally dealt with by the investigator, both in the research protocol and in implementation of the project.

Many other safeguards are required in human subject's protocols. Precautions are included to minimize risk and to determine when an individual's participation would be terminated or when the study itself would be terminated. High risk groups such as minors or institutionalized persons (e.g. hospitalized patients) must be used discriminantly. Measures to maintain confidentiality must be described but may include exceptions which anticipate the dual role of practitioner and researcher. Of course, informed consent must be obtained.

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These issues will continue to be explored within clinical nursing practice but an understanding of them is valuable to all researchers.

### RESPONSE SURFACES FOR BINARY EVENTS--AN EMPIRICAL BASIS FOR RADIATION ONCOLOGY

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Congent and clinically useful answers to the insistent questions of radiation oncology may be derived from clinical data (obtained by either observation or experiment) through the application of multivariate probit and logistic methods to these data.

The methods provide a statistically adequate representation, a response surface, of the basic concerns of the oncologist and his patient which are the *binary* events ( $E_i/E_j$ ) or irradiation and the conditions which fix the likelihood of their occurrence. These are the primary, simple, events by which the status of the neoplastic and normal tissues of the target volume are evaluated; that is, ablation,  $E_1/\bar{E}_1$ , and complication,  $E_2/\bar{E}_2$ , respectively, and the joint events derived from success,  $S = E_1$  and  $\bar{E}_2$ , or a failure,  $\bar{S} = E_1$  or  $E_2$ . The conditions for the occurrence of these primary and derivative events are, of course, the *adjustable* variables of treatment described by the vector  $X$  with elements dose, time, etc., the *fixed* prognostic features of the patient which are subsumed into the vector  $Y$  with elements size of target volume, stage of disease, etc. and the *time at risk*,  $t$ .

The response surface method was chosen over alternative statistical reductions because it is simple, empirical and provides a representation of clinical events in which may be readily discerned the entire repertoire of those concepts and precepts of radiation oncology which are both familiar and useful to its practice: curves of dose-response, iso effect and treatment characteristic, score function, probability of uncomplicated control, tolerance dose, optimization of treatment, design of clinical trials etcetera.

### THE CONTROLLED CHEMICAL DEGRADATION OF N<sup>5</sup>-METHYLTETRAHYDROFOLIC ACID

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The vitamin folic acid is rapidly converted *in vivo* to a large family of closely related structures which serve the various coenzymatic functions of one-carbon metabolism. These coenzymes exist in several states of reduction and may possess a number of different single carbon

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substituents at positions N<sup>5</sup> and/or N<sup>10</sup>. In addition they may have from one to seven or more additional glutamic acid residues in  $\gamma$ -peptide linkage. Studies aimed at understanding the biological role of these  $\gamma$ -glutamyl peptides of folic acid are presently inhibited by the absence of effective procedures for their determination.

We report here a rapid quantitative procedure for the cleavage of N<sup>5</sup>-methyltetrahydrofolate at the C<sup>9</sup>-N<sup>10</sup> bridge, generating p-aminobenzoylglutamate and an unidentified pteridine. This method employs peracid treatment and is nondestructive of  $\gamma$ -peptide bonds.

Briefly,  $\mu$ mole quantities of N<sup>5</sup>-methyltetrahydrofolic acid in 5.0 ml 50% trifluoroacetic acid are reacted with a 10-fold excess of peracetic acid at room temperature for 30 minutes. The reaction mixture is taken to dryness *in vacuo* at 35° and the residue taken up in 10 ml H<sub>2</sub>O and adjusted to pH 7.0. The sample is then purified by DEAE cellulose column chromatography. The quantitative recovery of p-aminobenzoylglutamate is reproducibly obtained.

## ENGINEERING

### DIGITAL PROCESSION OF SYNTHETIC APERTURE RADAR (SAR) DATA

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The purpose of this presentation is to describe an overview of the digital procession of SAR data. Covered are the following topics: digital procession functions, motion compensation, sidelobe control, and correlation of reference and received signals. More specifically, the objectives of motion compensation and sidelobe control (or apodization) are discussed in addition to the resultant degradation of image quality provided these processing algorithms are not employed. Also covered is the formulation of the correlation surfaces by use of Fourier transformation techniques. Finally, digital processing advantages and disadvantages are discussed.

### RADAR POINTING ERRORS DUE TO AERODYNAMIC RADOMES

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A radome is a protective covering for an antenna and is intended to leave the performance of the antenna unaffected. There are considerable trade-offs in the design of missile radomes which must be highly streamlined for good flight characteristics while at the same time not reducing

radar performance significantly. The radar performance of primary interest in this study is pointing error which is the difference in the angle to the target and the angle the radar indicates to the target. Pointing error is due to distortion of the radar wavefront as it passes through the radome.

The radome considered is a dielectric shell in the shape of an ogive. The fields incident on the antenna are obtained by a ray tracing technique and the response of the antenna is calculated using aperture integration. Radar pointing error is shown to be a function of the radome material as well as the polarization of the incident wave.

#### SCATTERING BY A PERFECTLY CONDUCTING SPHERICAL SHELL WITH A CIRCULAR APERTURE

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The electromagnetic scattering behavior of a perfectly conducting, infinitesimally thin, spherical shell with a circular aperture is studied. A time-harmonic plane wave is symmetrically incident upon the aperture. The E field integral equation is used to produce coupled integral equations for the tangential components of currents on the shell. The equations are cast into matrix form by application of the method of moments and numerical solution techniques are discussed.

#### DETERMINATION OF THE DRIVING-POINT IMPEDANCE FOR A POST-MOUNTED DEVICE IN A RECTANGULAR WAVEGUIDE

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The availability of low cost microwave semiconductor devices has made the method of post-mounting devices in waveguides increasingly important in recent years. The most common of these devices is the microwave diode which is used as a source of microwave oscillations or amplification. The post and device present an impedance to a propagating disturbance in the waveguide. The device is also presented a driving-point impedance that is critical to its operation.

The driving-point impedance of the device is determined by two methods. The first method utilizes a dyadic Green's function for the rectangular waveguide and an assumed current distribution for the post. These are then used to determine the electric field distributions for the post and associated gap. The driving-point impedance is then calculated using this electric field and current distribution. The second method utilizes experimental data to find the driving-point impedance.

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This method determines the driving-point impedance by finding an equivalent circuit of the post-mounted device centered in a matched waveguide. Each method yields acceptable results and either can be used to achieve the same degree of accuracy.

### MAGNETIC CORE AND SEMICONDUCTOR MEMORIES

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In this paper I have tried to enumerate and compare the two widely used computer memory systems--the Magnetic Core and Semiconductor Memories.

The basis of Core Memory System is the availability of a Hysteresis loop (the B-H curve). We use magnetic core for reading and writing information in 3 ways--3D, 2D or 2 1/2D systems. They can be used for several logic circuits. There are some engineering problems due to non-rectangularity of Hysteresis loop and energy loss per cycle which can be subdued by strobing techniques. Magnetic Core has the property that it depends upon switching time, temperature (up to Curie temp.) and also on high frequencies.

The Semiconductor Memories use IC's and memory chips called memory cells. The types of Semiconductor Memories are Random Access Memory (RAM), Read Only Memory (ROM), Control Memory (CM), Programmable Read Only Memory (PROM), Bipolar and n,p MOS (Metal Oxide Semiconductors) and Charge Coupled Device. RAM is used for sequence of instructions called by CM and ROM is used for library routines to store the functions or sub-routines permanently on the memory having nondestructive readout.

The Semiconductor Memories and Magnetic Cores are compared on the basis of Memory Access Time, Cycle Time Cost per Bit, Readout, Reliability, Capability, Volatility and there is a "Trade Off" between certain parameters. The comparison is based on Figure of Merit also. Forecast is made for better future of S. C. Memories in 1980 by one to three magnitude. Hope CCDs and BubbleTech. will also play a role.

Thus Semiconductor Memories in general can be more useful due to low access time, cost per bit, nondestructive readout etc. and hope by 1980 it will be more extensively used.



OPTIMAL NONLINEAR STRUCTURE PRESERVING FEATURE EXTRACTION

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In real world situations, quite often the dimensionality of the measurement space is high, while the number of training vectors available is small. In such a case, many feature extraction techniques are virtually useless for they are based upon class conditional statistics and such statistics cannot be estimated accurately. Other techniques such as those based on the Karhunen-Löve expansion require knowledge of the lumped data covariance matrix, which again is difficult to estimate accurately under real world constraints.

As a result, this study was undertaken to develop a method for nonlinear feature extraction based upon structural (graph theoretical and topological) attributes as well as other structures from cluster analysis.

IMPROVED ACQUISITION IN OPERATIONAL GAMING MODELS

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This paper describes the model incorporated into the como simulation to measure radar acquisition more accurately in a hostile (electromagnetic) environment. The model permits the analyst to set up realistic scenarios using standoff, escort, and self screening jammers and to measure dynamically their impact on the acquisition radar sidelobes.

DETERMINATION OF OPTIMAL CONTROL PARAMETERS:  
AN APPLICATION OF MATHEMATICAL PROGRAMMING

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The implementation of control laws in simulation studies often require the apriori estimation of one or more control parameters. Furthermore, these parameters are usually unknown functions of such exogeneous system parameters as distance, time, height, etc. The usual approach for obtaining parameter values is to make an estimate and then to run the simulation to determine the success or failure of this estimate. This paper presents a review of several nonlinear programming techniques which can be used to refine initial parameter estimates. An example is given where the authors used the Hooke and Jeeves algorithm to determine a set of system control parameters in the implementation of a missile control law.



## Abstracts

### ON THE ECONOMICS OF SIMULATION

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Unquestionably the original impetus to the massive permeation of simulation technology into our society was through the aerospace industry. The period following World War II was marked by an accelerated trend toward automation where computers, themselves a high expression of automation, played an important role in the control process and automation. Much of the activity was sparked by wartime efforts in development of sophisticated staff planning on a massive scale. The extension from computer programmed staff planning such as evidenced in models of linear programming and game theory within the military structure to modeling of specific aerospace systems evolved with the widespread influx of high speed analog and digital computers into the nation's industrial capital equipment inventory. The degree to which simulation of aerospace and defense oriented systems is funded is an elusive figure. However, in this paper an attempt is made to quantify the investment and savings accrued in missile simulation activity.

### ON THE DETERMINATION OF UNSPECIFIED $t_f$ IN A GUIDED MISSILE OPTIMAL CONTROL LAW APPLICATION

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Harold L. Pastrick  
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The performance of any realistic optimal control law in a missile application is dependent on the estimation of final time, or equivalently, on time-to-go. Typically, an estimate of the range between the target and missile and the rate of change of this range is obtained from radar or other ranging devices; the time-to-go estimate is then calculated. This estimate works quite well as long as the range and range-rate information are accurate. In many instances, however, the data are contaminated by noise either covertly, as in the case of radar jamming devices, or by the processing electronics. This adversely impacts the estimate of time-to-go and the optimal control law; and missile performance suffers. This paper presents a discussion of several aspects of the problem in the context of a realistic application and provides analytic computer algorithms for its solution, as well as a closed-form result.

## Abstracts

### MULTI-TARGET CHARACTERISTICS OF A DUAL MODE SPIRAL MONOPULSE SYSTEM

R. E. Daniels and E. K. Jackson  
Computer Sciences Corporation

The logarithmic spiral antenna is of special interest for direction finding because of its broad beamwidth, compact size and "almost" frequency independent characteristics. The multi-signal characteristics of a particular log-spiral direction-finding system is examined and contrasted with the characteristics of better known phase- and amplitude-comparison systems. Simulation results for a variety of dual-source cases are presented for various separation angles and relative powers. The affects of these variations on the average indicated angle and error variance are presented.

### NEW TECHNIQUES FOR STUDIES IN ORBIT TRANSFER

J. W. Crenshaw  
Computer Sciences Corporation

Deyst's method for solving the Lambert problem has proven to be a much more efficient approach to studies of orbit transfer than classical methods. However, an iterative solution to the unified equivalent of Kepler's equation is still required. For problems in which time is free, an alternative approach is presented using Deyst's intermediate parameter  $y$  as the independent variable. The resulting method gives very rapid solution for the velocity impulses required.

### EVALUATION OF RANDOM INPUT DESCRIBING FUNCTIONS

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In this paper various techniques of covariance analysis are discussed. Particular emphasis is placed on the calculation of the covariance matrix of a nonlinear system using describing functions for linearization. A problem in the use of these random input describing functions is the calculation of the describing functions. It is shown that, in general, this technique of covariance analysis is practical only if the random input describing function can be derived in closed form.

## Abstracts

### PREPROCESSING ALGORITHMS APPLIED TO IMAGE REGISTRATION

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Digital image registration systems that operate in real time require a number of preprocessing steps. The preprocessing algorithms presented in this study reduce the vast amount of data to a workable size. The study reported on here presents a block diagram of the registration system and the algorithms necessary to reduce the image data from a multi-bit to a few bit representation. Two image matching functions are given and the results of a signal-to-noise ratio analysis for few bit quantization applied to these functions is summarized.

Methods used to select quantization thresholds are outlined. For the case in which the signals are quantized to one-bit, the degradation of the mean square signal-to-noise ratio for small errors in the threshold is given. The results of a computer simulation of the image registration system are presented and briefly explained.

### A VARIABLE STEP, SELF-STARTING MULTISTEP NUMERICAL INTEGRATION METHOD

J. W. Crenshaw  
Computer Sciences Corporation

Classical multistep integration methods such as Adams-Moulton offer advantages over single-step methods in the areas of execution time and accuracy. However, such methods are not self-starting, and are designed for a fixed integration step. In this paper, w-transform techniques are used to permit alteration of the step size without restarting. It is shown that the same technique can be used to build the initial difference table, thus permitting a self-starting method.

### HARDWARE-IN-THE-LOOP SIMULATION APPLIED TO MISSILE GUIDANCE STUDIES

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The technique of using actual missile guidance hardware components combined with mathematical models in a closed loop dynamic real-time simulation is described for a particular system configuration. The use of a modern radio frequency target environmental simulator is also included in the description. Some results are presented for a series of studies whose objectives were the investigation of missile performance boundaries in scenarios which contained multiple and intermittently

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operating guidance information sources. Use of such results in deriving an overall system mathematical model is also discussed.

### STABILITY AND CONTROL OF A HYPOTHETICAL CAPITALIST ECONOMY

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Dynamic modeling and control theory techniques are used to analyze the adequacy of the process by which capital goods are accumulated in a hypothetical capitalist economy. The accumulation process is modeled by mathematical equations which are compatible with the assertions of Karl Marx. Adequacy is then defined in terms of stability of the mathematical model and is shown to be dependent on initial conditions and certain parameters in the model. Moreover, the accumulation process is shown to have undesirable features, such as inability to select an operating point and poor response to disturbances.

Techniques of modern optimization theory are next used to derive an economic "control policy" which removes some of the undesirable features of the accumulation process. The control policy is derived in the form of a "redirection of investment" and a closed-loop implementation of that policy is found. The proposed control policy permits the selection of a stable operating point, provides rapid recovery from disturbances, and allows for orderly economic growth as the population grows.

### FINITE CYLINDRICAL SCATTERER NEAR IMPERFECTLY CONDUCTING GROUND

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A pocklington type integro-differential equation is formulated for the current induced on a cylindrical scatterer near a finitely conducting ground. The reflection coefficient method is employed to relate the current on the image cylinder to that on the object cylinder. The formulation is reduced to a system of algebraic matrix equations suitable for numerical evaluation through application of the method of moments. The singularity expansion method is used to obtain the transient response of the induced currents. Numerical results will be presented in the form of graphs and tables.

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### ANTHROPOLOGY

#### PARENTAL REACTIONS TO THE LOSS OF A CHILD

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The loss of a child in today's society is thought by many people to be a very infrequent occurrence. However, each year between 10,000 and 15,000 infants in the United States die of "sudden infant death syndrome," and thousands more from the result of accidents, illnesses and other causes.

The effects of such an experience as child loss leads to a painful period of re-adjustment for parents. Many times one or both parents are unable to make proper adjustments, which in many cases leads to the destruction of the family.

Twenty-five parents in the metropolitan Mobile area which lost children between the years 1965 and 1976 were intensively interviewed. There was considerable variation in the ages, incomes, education, and occupations of the parents. The ages of the children at time of death ranged from stillbirth to eighteen. Causes of child's death included: premature birth, SIDS, spinal meningitis, leukemia, cancer, caritis, toxemia, and accidents.

The death of a child evokes generalizable as well as unique reactions by parents. Reactions such as shock, a feeling of helplessness, and guilt cross all social-demographic categories. Extremes in certain behavioral patterns are the norm and should be expected after the loss of a child. A gradual return to normal patterns of behavior is experienced by most parents. However, the death of a child is forever a living part in the lives of the parents. The key to recovery in most cases is acceptance of the death as a finality.

#### DIET AND DEVELOPMENT IN BELIZE

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Belizean food habits are presented in historical perspective. The Belizean diet is traced from colonial times to the present day; and, historical data are presented which illustrate that other variables may influence diet besides the local environment. The kinds of foods and their methods of preparation are discussed in terms of how colonial rule

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has influenced the present day Belizean diet. Furthermore, to maintain the national diet requires the importation of large quantities of foods not locally produced in sufficient quantities to meet demand, and this situation has a negative effect on national economic development plans.

### SOCIAL STRUCTURE OF THE ANCIENT QUMRAN COMMUNITY

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A description is presented of the social structure of the Qumran community (cira 125 B.C.-68 A.D.) as depicted in key ancient manuscripts, especially those forming part of the Dead Sea Scrolls. Some attention is given to archaeological evidence and to writings from the first century A.D. pertaining to the Essenes of Pliny the Elder, Josephus, and Philo of Alexandria; but statements concerning economic organization, political organization, social ranking, law, and religion reflect principally the contents of the *Zadokite Document*, *Manual of Discipline*, and *War of the Sons of Light and the Sons of Darkness*.

The aforementioned community was awaiting the Final Age and the coming of a priestly and a lay Messiah. The organizational procedures and rules set forth in the *Zadokite Document* and the *Manual of Discipline* were meant to apply as interim measures. There were other rules for the era to follow the battle portrayed in the War scroll.

The Qumran sectarians were participating in a revitalization movement that failed to realize its ultimate goals; for their community was brought to an end by the Tenth Roman Legion which had been sent to crush the First Jewish Revolt. Some of their ideas, however, may have had some influence on the development of Christianity. The Qumran community was characterized by rigid organizational patterns, stringent rules to close the ideal-real gap, and several mechanisms for maintaining boundaries between insiders and outsiders.

### THE NARROW LANE SITE

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The Narrow Lane Site 1 Mt 231 (renamed Harrington Site) located along the north bank of the Catoma Creek about 12 miles south of Montgomery, Alabama, was discovered during a pipeline survey being conducted for the city of Montgomery Sanitary Water and Sewer Board. Adverse impact upon this site being unavoidable, a contract to conduct excavation as a mitigative action was drawn up between the Alabama Historical Commission and Auburn University at Montgomery. This exploration began in October, 1977.

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Subsurface evidence reflected two major components. The earlier being of a late Archaic provenience (Millbrook Phase) specifically identified through the recovery of large stemmed projectile points, bowl sherds of steatite, fiber tempered pottery and various heavy chopping and scraping tools. The later occupation indicated through the uncovering of many mica-tempered pottery fragments, small stemmed projectile points of the Bradley Spike, Swan Lake and Baker's Creek types a larger campsite of the Calloway Phase, a Middle Woodland period.

Of considerable interest were the 37 features uncovered. Of these, eight were human burial pits containing skeletons of six adults, one preadolescent child and one infant. Bone, both human as well as animal, was in excellent condition owing to the proximity of quantities of mussel shells and concentrations of wood ashes, both combining to lower the pH of the soil environment. Both flexed and extended positions were seen in burials. One burial contained an antler baton--possibly a chipping tool. Otherwise, no burial furniture was seen. Other features appeared to be pits of one type or another. Many of these contained high concentrations of wood ashes. From these pits were recovered extensive ecofact materials reflecting subsistence activities. Field identifications were made of hickory nuts, acorns and walnuts, as well as a number of small seeds. Faunal remains were common; with deer bone being most frequently found followed by turkey, turtle, fish and a number of other small mammal remains. One pit contained a disarticulated dog.

In view of the paucity of Middle Woodland data of this type in Central Alabama, the Harrington Site may be considered to be one of considerable archaeological significance.

### AN OUTPUT ANALYSIS OF JUDICIAL FAIRNESS: ABSENCE OFFENSES AND MILITARY JUSTICE IN THE VIETNAM ERA

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This paper attempts to evaluate the fairness of the military justice system in its processing of absence offenders during the Vietnam War by analyzing system outputs. Fairness is measured in two ways, the first of which is the degree to which extraneous factors such as social background and conditions of military service are uncorrelated with military justice outcomes. Second, a fair system is assumed to be reflected by the degree to which factors reasonably associated with the severity of the offense are correlated with outcomes. The samples used in this analysis are the absence offenders from the Notre Dame Survey of the Vietnam Generation ( $n = 147$ ) and the military offenders from a stratified random sample of the cases processed by the Presidential Clemency Board ( $n = 1009$ ). Some indications of non-fairness are found. Draftees received more severe punishments than volunteers. While length of absence was significantly related to severity of punishment, frequency of offense was not. Army personnel received especially light sentences,



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while the punishment of marines was especially harsh. Offenses committed early in the war were more severely punished than those committed later in the war.

### THE PHOENICIAN THEORY OF NEW WORLD ORIGINS

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Several theories have been developed concerning the origins of the native Americans. The Phoenician explanation was probably not the most popular of the theories, but it prevailed to some extent during the Seventeenth Century. Thereafter it lost its importance and was not revived until the Twentieth Century.

At the turn of the century, Zelia Nuttall, an Americanist delineated several parallels between the ancient cultures of the New World and those of the eastern Mediterranean area. She suggested that the Phoenicians were the principal agents for this diffusion.

In 1963, Constance Irwin, a professor of library science at the University of Iowa published a book in which she proposed a Phoenician explanation of Near Eastern traits in the high rise civilizations of ancient America, such as infant sacrifice, serpent symbolism, and belief in the Fair God.

Testing of the Phoenician theory of New World origins would require at least five categories of evidence: (1) textual studies, (2) geographical analyses, (3) somatic comparisons, (4) culture-trait comparisons, and (5) linguistic and paleographic studies. Developments in recent years have already provided certain kinds of information for these categories.

Most, if not all of the Phoenician-like inscriptions found thus far are located on the Atlantic Seaboard. Thus, it appears that we may not find any close connections between the semitic-type inscriptions found on the eastern coast of our Western Hemisphere and those found in the major culture areas of Mesoamerica.

### MIGRANT WORKERS IN BALDWIN COUNTY: A CASE STUDY OF ONE FAMILY

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Migrant farm laborers have been important in the United States agriculture for most of its history. Today, the migrant workers are mainly Mexican-American. These people have been here since the Spanish colonization of the West, and now form a major sub-culture in the United

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States. They have never joined the mainstream of American life, and today their numbers are growing. This paper is an attempt to bring an understanding of this sub-culture to others.

### WE'RE STILL HERE: THE CREEK INDIAN COMMUNITY OF POARCH, ALABAMA

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Poarch is a rural Escambia county community seven miles northwest of Atmore, Alabama. The approximately 500 inhabitants are descendants of Creek Indians remaining in south Alabama despite the 1830's federal policy of forced resettlement in Indian Territory (Oklahoma). The Poarch Creek are the largest contemporary population of self-identified Indians in the state.

The Poarch Creek maintain a third socioracial identity class distinct from the dominant society normally divisible in terms of a bi-racial (Negro-White) structure. Despite the inherent difficulties in continuing this identity, the Poarch Creek have insisted on recognition as Indians. Several factors including geographical isolation and de facto segregation have influenced continuity of Indian identity.

This paper will discuss factors affecting the continuity of Indian identity within the Poarch community and characteristics reflecting their Indian self-concept.

### THE DISINTEGRATION OF THE CREEK CONFEDERACY BEFORE THE ADVANCING FRONTIER

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Creek society in its natural setting was strong, flexible, and successful within the environment it had grown to respond to. With the introduction of a dominant white culture, however, Creek culture began a rapid deterioration due to the lack of a comparable resource capability to maintain its essential integrity.

The conscious policy to relieve the Indian of his land proceeded on several fronts and manifested itself in the reduction of the Indian to dependence upon the new civilization. Disintegration of the Creek way of life began at the first contact period. Increasing white influence was directly related to the demoralization of Creek society. The acculturation process accelerated and intensified with the introduction of direct restructuring of Creek society after the American Revolution.

The inability to communicate the needs of this policy necessitated the ultimate use of military force.

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### THE BLAKELEY SHELLMOUNDS: EVIDENCE OF CERAMIC EVOLUTION IN THE SOUTH ALABAMA WOODLAND

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During the summer of 1977, University of South Alabama personnel surveyed and tested site Ba229, the Blakeley shellmounds. A five foot by ten foot test excavation (Ba229-A) was conducted in order to provide a data base for future investigations of the mound/midden complex.

The artifact assemblage produced by this excavation indicates a rather long, continuous occupation by Bayou La Batre peoples beginning in the Early Woodland period. That this occupation extended well into the Middle Woodland is evidenced by the presence of the distinctive shell-stamped ceramics in the upper levels along with Porter Marksville pottery types. An examination of the Bayou La Batre material reveals an interesting change in tempering which appears to correspond to this association.

This paper consists of a brief history of previous archaeological research at Ba229 plus a description of the 1977 field work and recovered artifacts. Also included is a discussion of the evolution in ceramic temper in relation to neighboring culture areas.

### THE ROLE OF LITHIC TYPOLOGY IN RESEARCH DESIGN OF THE MOBILE DELTA

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The objective of this study is to outline a strategy by which analysis of material culture contributes to our understanding of cultural processes and systems. The appropriate universe of study is the region, analysis of which is made feasible by recent developments in computer technology and systems theory and is necessitated by the spectre of industrial and commercial expansion in South Alabama.

Certain basic guidelines are proposed by which lithic typology in the Mobile Delta may be meaningfully integrated into the holistic regional model. Field methodology must incorporate valid sampling theory. This entails the random selection of investigative units from gridded surfaces of the entire region and from individual sites.

Lithic classification must embody analysis of function and multiple stylistic traits. Thus typology is concerned with implied "use" of artifacts and with "ideal types" based on such attributes as form, length, width, weight and manufacturing technique.

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Research should focus on the technico-economic subsystem and in particular problems of subsistence base and settlement patterns. It is expected that such a rigorous and comprehensive investigation of the Mobile Delta will contribute substantially to Southeastern regional prehistory.

## CHEMISTRY

### GC/MASS SPECTROSCOPY: SOME NEW INSTRUMENTATION

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The conversion of an RMU-6M instrument, in conjunction with a Tektronics computer system and a gas chromatograph capable of handling capillary columns was described. One of the major features of this new combination system involves the utilization of a newly developed computer program, which has the following capabilities:

1. Corrects raw data to 100% corrected spectra.
2. Calculates the 11 most intense peaks for comparison with literature and computerized known mass spectral data.
3. Is capable of subtracting the spectral background or any other spectrum from a given one.
4. Calculates probable molecular formulae based upon isotope distributions.
5. Calculates possible molecular ion fragments lost.
6. Calculates possible molecular ion fragments formed.

A silicon membrane separator is utilized to split the gas chromatographic affluent between the flame ionization detector of the gas chromatograph and the mass spectrometer. The total residency time of material in the ion chamber is, for molecular weight compounds of approximately 300, a total of 0.5 seconds.

Transfer of the raw data from the mass spectrometer to the random access memory of the computer is approximately 0.6 seconds. The system is capable of handling 5 nanogram amounts routinely.

An example of the use of the system was presented showing the analysis of nutmeg oil extract and the identification of 19 of the 22 components eluted from a 150 ft. metal capillary column coated with emulphor.

Minimum peak separations necessary for a complete mass spectral analysis are estimated at 2 seconds.

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The computer program utilized in this system can be employed for any of the inlet modes and is available either from the authors or Tektronics Incorporated.

### SOME NEW AND GENERAL CORRELATIONS IN $^{13}\text{C}$ NMR SPECTROSCOPY

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A new and general set of Carbon-13 correlation constants was developed. Past attempts by numerous authors to correlate Carbon-13 chemical shifts in benzenoid systems with those of various heterocyclic aromatics has led exclusively to failure. The best coefficients of correlation obtainable have been approximately 0.65.

Recognition that a given substituent on an aromatic system will effect the charge distribution at the substituted carbon differently, depending upon the *total electron availability of the ring system*, prompted us to develop a set of constants which takes this into account.

$$\text{The equation: } \log \frac{[\delta_{\text{het-x}}]}{[\delta_{\text{het-x}}]} = \rho_{\text{C}} \sigma_{\text{C}}$$

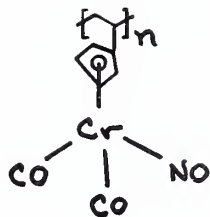
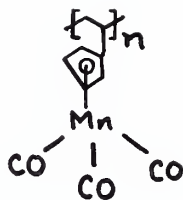
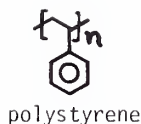
has been developed and is utilized in a fashion whereby a series of substituent constants for benzenoid substituents is developed. The sigma values, thus obtained, with  $\rho = 1.0$ , are then utilized in determining the value of  $\rho$  in the above equation.

As anticipated  $\rho_{\text{C}}$  is larger than 1 in  $\pi$ -excessive heterocyclic systems, and is smaller than 1 in  $\pi$ -deficient system. Thus, not only can  $\text{C}_{13}$  chemical shifts now be predicted, based upon the substituent constants and an understanding of the nature of the aromatic ring, but a quantitative measure for the evaluation of  $\pi$ -deficiency and  $\pi$ -excessiveness of heteroaromatic ring systems has now been made available. The coefficient of correlation for these relationships, in all instances, is better than 0.95.

### HYDRODYNAMIC STUDIES OF SOME NOVEL METAL CONTAINING POLYMERS-- CORRELATION OF CHAIN FLEXIBILITY WITH MONOMER VOLUME

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Sedimentation equilibrium and sedimentation velocity experiments have been done on the following polymers:



All of the metal containing polymers appear to be stiffer and have extended conformations relative to polystyrene. The radius of gyration for the metal containing polymers is proportional to the molecular weight to the 0.7 to 0.8 power in THF at 20°C. Polystyrene under these same conditions has a  $R_g \propto M^{0.55}$  which is typical for random coils. The rod-like nature of the metallocene polymers may be either steric or electronic in origin. At present studies of styrene copolymers are underway with the hope of establishing the predominant contributor to the expansion.

This work was supported in part by Research Corporation and in part by the University of Alabama Research Grants Committee.

#### PROTON IONIZATION FROM FLEXIBLE POLYMERS--A COMPARISON OF POLYVINYLAMINE AND POLYACRYLIC ACID

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Calorimetric and potentiometric titration experiments have been done on polyvinylamine (PVA) and on polyacrylic acid (PAA). The thermodynamic parameters  $\Delta G$ ,  $\Delta H$ , and  $\Delta S$  for proton ionization from these polymers have been obtained. These data for PVA appear quite anomalous in that a plot of the apparent  $pK$  versus degree of protonation is essentially linear. Classical interpretation of this plot would suggest that the solution conformation of PVA is not influenced by electronic charge or charge distribution. An alternative explanation based on nearest neighbor interactions and on polymer backbone configuration is proposed.

This work was supported in part by Research Corporation and in part by the University of Alabama Research Grants Committee.

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### PREPARATION AND CRYSTAL STRUCTURE OF $C_{p2}ZrClMe$

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$(C_5H_5)_2ZrCl(CH_3)$  was prepared by the reaction of  $(CH_3)_3Al$  with  $[(C_5H_5)_2ZrCl]_2O$ . The compound crystallizes in the monoclinic space group  $P2_1/n$  with cell parameters  $a = 6.810(6)$ ,  $b = 11.821(5)$ ,  $c = 13.818(6) \text{ \AA}$ , and  $\beta = 92.30(4)$ . The final R factor was 0.044 based on 1709 independent observed reflections. The chlorine atom and the methyl group are disordered in a statistical fashion. The Zr-Cl lengths are 2.43 Å, and the Zr-C, 2.35 Å.

### REACTION OF ALUMINUM ALKYLs WITH CROWN ETHERS

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Trimethylaluminum reacts with 18-crown-6, dibenzo-18-crown-6, and 15-crown-5 to form weak donor-acceptor complexes. In the case of dibenzo-18-crown-6, the stoichiometry is approximately 3:1. These complexes may be reacted with salts such as  $KN_3$  to give new compounds of the form  $[K \cdot \text{crown ethers}][Al_2(CH_3)_6N_3]$ . The weakness of the Al-O bond in the initial complex is attributed to the inaccessibility of the oxygen atom in the planar framework.

### SYNTHESIS AND X-RAY STRUCTURE DETERMINATION OF N-LITHIOHEXAMETHYLDISILAZANE-BULKY LIGAND EFFECTS

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The University of Alabama  
University, Alabama 35486

The crystal structure of  $[LiN(SiMe_3)_2]_3$  was determined from single-crystal X-ray diffraction data collected by counter methods. N-lithiohexamethyldisilazane crystallizes in the monoclinic space group  $P2_1/c$  with unit cell parameters  $a = 8.848(4)$ ,  $b = 31.868(9)$ ,  $c = 12.325(4) \text{ \AA}$ ,  $\beta = 104.93(3)^\circ$ , and  $\rho_{calc} = 0.99 \text{ g cm}^{-3}$  for  $Z = 4$  trimeric units. Least-squares refinement gave a final conventional R value of 0.050 for 2449 independent observed reflections. In the solid state the compound exists in a trimeric configuration with a planar  $Li_3N_3$  ring. The average Li-N length is  $2.00(2) \text{ \AA}$ , and the ring angles are  $N-Li-N = 147(3)^\circ$ , and  $Li-N-Li = 92(2)^\circ$ . A greater degree of covalency in the title compound compared to  $Na[N(SiMe_3)_2]$  and  $K[N(SiMe_3)_2] \cdot 2C_4H_8O_2$  can be inferred from the Si-N bond length of  $1.729(4) \text{ \AA}$ .



## Abstracts

### THE EFFECTS OF STRUCTURAL DISTORTION ON THE LIGAND EXCHANGE REACTIONS OF COPPER(II)-SCHIFF BASE COMPLEXES

Gary R. Dukes and Steve R. Lovelady  
Department of Chemistry  
The University of Alabama  
University, Alabama 35486

The kinetics of the ligand exchange reactions of a variety of bis(N-substituted-salicylaldehyde)copper(II) complexes were examined to determine the effects of structural distortion on the rates of these reactions. The reactions are second order overall--first order each in copper complex and ethylenediamine concentration--and evidence is presented which indicates that the rate determining step involves the opening of a Schiff base chelate ring. The proposed mechanism involves coordination of one end of ethylenediamine to one of the axial positions of copper in the Schiff base complex in a rapidly established pre-equilibrium with the rate step being a concerted ethylenediamine--ring-closing, Schiff base--ring-opening step. The rate of the ligand exchange reactions of the distorted complexes is faster than those of their isomerically related square planar complexes. It has been postulated previously that in the absence of Jahn-Teller effects the rates of ligand substitution reactions of metal complexes should decrease. However, the faster rates of ligand exchange exhibited by the distorted complexes in which the influence of Jahn-Teller effects should be significantly reduced compared to the square planar complexes suggests that Jahn-Teller effects may be relatively unimportant factors affecting the rates of substitution reactions at metal centers.

### TITRATION CALORIMETRIC STUDIES OF POLYMER BOUND REAGENTS--INSTRUMENT DEVELOPMENT AND APPLICATIONS

Edwin A. Lewis and Andrew Meyers  
Department of Chemistry  
The University of Alabama  
University, Alabama 35486

Two different flow through columns designed for packing with polymer supported reactive groups have been inserted into the 3 ml reaction vessel of a TRONAC 450 isoperibol calorimeter. Both columns were constructed from thin wall stainless tubing with the first coiled from approximately 15 cm of .8 mm I.D. tubing and the second a straight length (~0.8 cm) of 3 mm I.D. tubing. A plexiglass spacer between the header plate and reaction vessel top was used to bring the reagent lines in and out of the dewar. Trial systems using columns packed with Dowex AG 1 (an anion exchange resin) and anions; OH<sup>-</sup>, F<sup>-</sup>, Cl<sup>-</sup>, Br<sup>-</sup>, and I<sup>-</sup> and with Dowex AG 50 W (a cation exchanger) and cations; Li<sup>+</sup>, Na<sup>+</sup>, K<sup>+</sup>, Cs<sup>+</sup>, and NH<sub>4</sub><sup>+</sup> proved the feasibility of this flow through thermal analysis system. The measured heats for these exchange reactions were in good agreement with the best literature data. The thermograms for these titrations show a continuous increase (or decrease) in temperature until the reactive sites on the column are saturated followed by a relatively sharp

end-point and a decay back to the bath temperature. This novel technique may prove to be a new analytical method of significance particularly if columns employing polymer bound enzymes work as well as the systems tested in this study.

This work was supported in part by Research Corporation and in part by the University of Alabama Research Grants Committee.

#### DIELECTRIC CONSTANTS OF FUSED SALTS

Wayne Patterson and Ervin R. VanArtsdalen  
Department of Chemistry  
The University of Alabama  
University, Alabama 35486

The dielectric constant is an important property in understanding structure and behavior of molten salts. In particular, it may be used in helping to elucidate the mechanisms and kinetics of ionic reactions in melts. However, until now, only guessed-at values have been available. We report here the first reliable measurements of the dielectric constants of fused salts.

The dielectric constant of highly conducting liquids such as fused salts cannot be determined by the customary methods which may use condenser plates or electrodes immersed in the liquid. Rather, some method which obviates conductance through the liquid must be used. Our technique employed cylindrical quartz or pyrex cells with a small-bore coaxial insulating tube of the same material. One electrode was a bright platinum coat on the outside of the cell while the other electrode was a heavy platinum wire fixed firmly inside the small coaxial tube. Pyrex cells appear to be limited to a maximum temperature near 170°C, above which some relaxation of the glass may occur. The capacitance of the cell was measured with a precision capacitance bridge. Several liquids including benzene, aniline, ethanol and water, whose dielectric constants lie between 2.3 and 78.5 and are known accurately as a function of temperature, were used to calibrate the cells.

The dielectric constants for several molten nitrates lie in the range of 12 to 20 and show the expected decrease with rising temperature.

#### CLEAVAGE SPECIFICITY OF THE ENDOGENOUS $Mg^{+2}$ DEPENDENT NUCLEASE FROM RABBIT THYMUS--SUBUNIT STRUCTURE OF COMPACT NUCLEOHISTONE

Edwin A. Lewis and Ronald Stephens  
Department of Chemistry  
The University of Alabama  
University, Alabama 35486

The endogenous nuclease exploited by Lewis et al. (1976) and earlier by Rees et al. (1974) to degrade rabbit thymus chromatin to a soluble compact nucleohistone has been examined with respect to its site of

## Abstracts

cleavage. EcoRI and Hind III restriction endonuclease digestion fragments of  $\lambda$  phage DNA were used to establish approximate molecular weights of the DNA fragments isolated from the rabbit nucleohistone particles using standard agarose gel electrophoresis techniques. The observation of discreet bands for the nucleohistone DNAs, with molecular weights appearing to be integral multiples of from 100 to 150 base pairs indicates that the specificity of the endogenous enzyme is similar to that of micrococcal nuclease A, and further it substantiates the subunit structure of the nucleohistone described earlier by Lewis et al. and by Rees et al.

Lewis, E. A., DeBuysere, M. S., and Rees, A. W., *Biochemistry* 15, 186-192 (1976).

Rees, A. W., DeBuysere, M. S., and Lewis, E. A., *Biochim. Biophys. Acta* 361, 97-108 (1974).

This work was supported in part by Research Corporation and in part by the University of Alabama Research Grants Committee.

### DIFFERENTIAL RECOGNITION OF AMIDE AND ESTER BONDS BY PROTEOLYTIC ENZYMES: HYDROLYSIS OF PEPTIDE AND ESTER SUBSTRATE: CATALYZED BY THERMOLYSIN

Roger Rowlett and Joe Murphy  
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The University of Alabama  
University, Alabama 35486

Thermolysin (TLN) is a thermostable neutral protease isolated from the thermophilic bacterium *Bacillus thermoproteolyticus*. It is mechanistically similar to carboxypeptidase A (CPA), and both enzymes exhibit both esterase and peptidase activity. For CPA there is substantial evidence that structurally analogous ester and peptide substrates bind to separate sites; most notably peptide substrates are noncompetitive inhibitors of ester hydrolysis. In addition, inhibitors that are competitive towards peptides are noncompetitive towards esters, and vice versa.

The peptide substrate chosen for TLN is carbobenzyloxyglycyl-L-leucyl-L-alanine (CGLA) and the structurally similar ester used is hippuryl-L-mandelyl-L-alanine (L-HMAIa). In contrast to CPA, peptides are generally hydrolyzed much faster than esters by TLN, and it is observed that the above ester substrate is a noncompetitive inhibitor of CGLA hydrolysis. Furthermore, the  $K_i$  for inhibition is close to  $K_m$  for L-HMAIa.

The modes of inhibition observed for several peptide and ester substrate fragments are not as easy to interpret as for CPA. In general, four modes of inhibition are seen: uncompetitive (UC), mixed noncompetitive (M), competitive (C), and no inhibition (N). Some results are summarized below:

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Inhibitor	L-HMA1a $K_I$ (mode)	CGLA $K_I$ (mode)
$(C_6H_5)_2C(OH)CO_2H$	11mM (M)	52mM (C)
$L-C_6H_5CONHCH(CH_3)CO_2H$	24mM (C)	(N)
$L-C_6H_5CH_2OCONHCH(CH_2C_6H_5)CO_2H$	.37mM (C)	2.3mM (C)
$L-C_6H_5CONHCH_2CO_2CH(C_6H_5)CO_2H$	6.4mM (UC)	18mM (C)

Although the above data does not lend itself to a simple interpretation, it nevertheless suggests a fundamental difference in the recognition of ester and peptide substrates by TLN. This work was supported by the Research Grants Committee and the Graduate School of the University of Alabama.

## EVIDENCE FOR RACEMIZATION IN THE NITROUS ACID DEAMINATION OF L-LEUCINE

Richard Linton, Karen Harrell, and Joe Murphy  
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The University of Alabama  
University, Alabama 35486

The reaction of  $\alpha$ -amino acids with dilute aqueous nitrous acid is commonly believed to proceed with complete retention of configuration at the  $\alpha$ -carbon. The evidence presented below demonstrates that, in the case of L-leucine [ $I:X-CH(CH_2CH(CH_3)_2)CO_2H$ ,  $X = -NH_2$ ] the reaction with dilute aqueous nitrous acid or with nitrous acid in 6M HCl yields 2-hydroxy or 2-chloro-4-methylvaleric acid [ $I:X = -OH$  or  $-Cl$ ] in which the degree of retention is quite small, and substantial racemization has occurred. Treatment of the optically active hydroxy-acid  $I:X = OH$  with hippuryl chloride in the presence of pyridine yielded the ester,  $I:X = C_6H_5CONHCH_2CO_2^-$ , only 60% of which could be hydrolyzed by the enzyme carboxypeptidase A at pH 7.5, although all of the ester was susceptible to base hydrolysis at pH 11.0. Since esters of this type will be hydrolyzed by carboxypeptidase A only if they have the L configuration, one must infer that the ester is a mixture of 60% L and 40% D isomers, suggesting that the original  $\alpha$ -hydroxy-acid,  $I = X = OH$ , is 80% racemic by weight. The  $^{13}C$ -nmr spectrum of the methyl ester of the  $\alpha$ -hydroxy-acid in  $CDCl_3$  solution contained a sharp peak for the  $\alpha$ -carbon at 75 ppm, which was shifted downfield and split into two broad peaks of relative area 60:40 when saturating concentrations of the chiral lanthanide shift reagent, tris-[3-(trifluoromethylhydroxymethylene)-d-comphorato]europium (III) were present. Similar behavior was observed for the analogous racemic methyl ester, although here the relative peak area was 1:1. The  $^1H$ -nmr of the methyl ester of the  $\alpha$ -chloro acid ( $I:X = Cl$ ) contained a sharp singlet for the  $OCH_3$  methyl group which, upon addition of the same chiral shift reagent, was shifted downfield and separated into two singlets of relative area 60:40.

This work was supported by the Research Grants Committee and the Graduate School of The University of Alabama.

## Abstracts

### STUDIES OF THE STRUCTURAL STABILITY OF THE THERMOSTABLE PROTEOLYTIC ENZYME THERMOLYSIN

James Hoeferlin, Edwin Brown, and Joe Murphy  
Department of Chemistry  
The University of Alabama  
University, Alabama 35486

In aqueous solution, the enzyme thermolysin requires temperatures in excess of 80°C for denaturation. Our evidence indicates that this remarkable structural stability is due, at least partly, to hydrophobic bonding and, to some extent, hydrogen bonding within the enzyme molecule. We have examined the effects of water-miscible organic solvents (methanol, ethanol, 1-propanol 2-methoxyethanol, acetonitrile, dimethyl sulfoxide) on the stability of the enzyme and on its thermal denaturation profile, using ultraviolet difference and fluorescence spectroscopy. In general, very high concentrations of organic solvents appear to be required for denaturation. For example, the native structure is apparently preserved in 90% acetonitrile. The minimum concentration of methanol, ethanol and 1-propanol required for denaturation shows a linear correlation with the hydrophobicity substituent constants,  $\pi$ , for the alkyl groups in these alcohols. Denaturation of the enzyme in D<sub>2</sub>O occurs at 85°C, compared to 80°C in H<sub>2</sub>O, suggesting that hydrogen bonds may also have some influence on the stability of the structure of thermolysin.

This work was supported by the Research Grants Committee and the Graduate School of The University of Alabama.

### CRYSTAL STRUCTURE OF $\text{Rb}[\text{Al}(\text{CH}_3)_3\text{N}_3]$

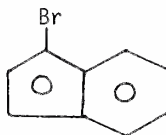
James M. Cummings and Jerry L. Atwood  
Department of Chemistry  
The University of Alabama  
University, Alabama 35486

The crystal structure of rubidium azidotrimethyl-aluminate was determined from three-dimensional counter data, and refined by full-matrix least-squares techniques. The crystals belong to the monoclinic space group  $\text{P}2_1/\text{n}$ , with  $a = 10.003(5)$ ,  $b = 7.497(4)$ ,  $c = 11.806(5)\text{\AA}$ ,  $\beta = 108.70(3)^\circ$ , and  $D_c = 1.58 \text{ g cm}^{-3}$  for  $Z = 4$ . The final R factor for 922 observed reflections is 0.049. The compound is not isostructural with  $\text{CsN}_3 \cdot \text{Al}(\text{CH}_3)_3$ . The aluminum atom is coordinated in a tetrahedral fashion, and the Al-N bond length is  $1.944(8)\text{\AA}$ .

THE CRYSTAL STRUCTURE OF  $(C_9H_6Br)Mn(CO)_3$

Michael Honan and Jerry L. Atwood  
Department of Chemistry  
The University of Alabama  
University, Alabama 35486

The crystal structure of the title compound has been determined and refined to an R value of 0.056. The configuration of the indenyl ligand is



The manganese atom is pi bonded to the five-membered portion of the ring at an average distance of  $2.16(4)\text{\AA}$ . The range is  $2.13$  to  $2.22\text{\AA}$ . The three carbonyl ligands are arranged in the "piano stool" configuration.

PHOTOCATALYSIS USING MATRIX-ATTACHED METAL CARBONYLS

Charles U. Pittman, Jr.  
Department of Chemistry  
The University of Alabama  
University, Alabama 35486

We wish to utilize photochemical catalyst generation to produce a series of active catalysts at low temperatures. Normally, catalysts such as metal carbonyls must be heated to high temperatures to generate catalytically active species (ie  $Fe(CO)_5 \xrightarrow{\Delta} Fe(CO)_3 + 2CO$ , where  $Fe(CO)_3$  is the active catalyst). By using light energy, the same catalysts can be used but now the active species (ie  $Fe(CO)_3$ ) may be generated at low temperatures. The catalytic reaction to be studied can now be run at low temperature. This may allow greater selectivity and, indeed, the observation of different products than were ever observed previously. To increase the quantum efficiency of such processes, we plan to attach the metal carbonyl catalysts into the three-dimensional network of supports, such as  $SiO_2$  or polymers. Thus, we hope to prevent certain recombination reactions that destroy the photogenerated catalyst. We are cooperating now on this project with Professor Mark Wrighton of MIT and a student exchange is in process.



## Abstracts

### METHANOL HOMOLOGATION

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As we switch from petroleum to coal as the source for liquid fuels, coal gasification and liquefaction will compete for preeminence. Gasification will generate syn-gas (i.e.,  $H_2$  and CO) as a raw material, from which methanol ( $CH_3OH$ ) will be prepared. Mobile Research Corp. has recently developed a methanol to gasoline process. The second possibility involves methanol to ethanol. Ethanol has a higher energy per weight ratio than methanol. We wish to study the homologation of methanol to ethanol (i.e.,  $CH_3OH + H_2 + CO \rightarrow CH_3CH_2OH$ ). In this process methanol (from syn-gas) is reacted with syn-gas so that the entire feedstock is syn-gas. We plan to study a series of catalytic processes in order to develop the most selective route possible. To date, we have achieved only 35% yields but very little work has gone on in our laboratories. The Pittsburgh Energy Center of ERDA has looked at  $Co_2(CO)_8$  as a catalyst, but we feel a series of Ru, Rh, or Ir catalysts have more promise.

The availability of chemical routes from syn-gas to liquid fuels (other than the Fischer Tropsch process) is necessary to fully evaluate the coal gasification route for coal to fuels.

### APPLICATION OF IMMOBILIZED HOMOGENEOUS CATALYSTS TO SYNTHESIS OF PETROCHEMICALS

Charles U. Pittman, Jr.  
Department of Chemistry  
The University of Alabama  
University, Alabama 35486

*Homogeneous* transition metal compounds catalyze a huge variety of chemical reactions at *lower temperatures* and with *greater selectivity* than *heterogeneous catalysts*. However, *heterogeneous catalysts* are more widely used in industry due to their ease of separation from the products and for engineering advantages. We are currently studying the *attachment of homogeneous catalysts* to polymeric resin supports so that they are "heterogenized" from the chemical processing standpoint, but "homogeneous" in terms of their high selectivity and the ability to use them at low temperatures. Their use will, in some cases, permit the synthesis of petrochemicals with (a) lower energy consumption and (b) in a greater yield with less loss of chemical feed. Currently, we are among the leading research groups in this area, and about 15-20 publications from our group have already appeared. Support is needed to permit us to undertake the anchoring of two different catalysts to resins to allow multistep reactions to be carried out in the same reactor. Reactions of importance include olefin dimerizations and oligomerizations, olefin hydroformylation, and both hydrogenation and dehydrogenation of petrochemicals.



## Abstracts

### METAL CLUSTERS AS "HOMOGENEOUS" METAL SURFACES

Charles U. Pittman, Jr.  
Department of Chemistry  
The University of Alabama  
University, Alabama 35486

Metal cluster compounds are discrete molecular compounds with three or more metal atoms. They frequently are polyhedral with triangular faces. Thus, multiple metal sites are available to catalyze reactions just as are available on metal surfaces. However, these cluster complexes are *soluble* and can be employed as *homogeneous* systems. Many reactions catalyzed by metal surfaces have never been achieved homogeneously (dehydrosulfurization, C-H activation, cracking, hydrocracking etc.). However, the use of metal cluster complexes, with more than one metal site available and with metal-metal bonds transmitting electronic effects, just may be a way to homogeneously catalyze these reactions. If this is achieved it will be a major basic research breakthrough. It would allow the usual tailoring of reactivity and selectivity (via choice of ligands and solvents) that is characteristic of homogeneous catalysis. Key goals include: (1) production of methane, ethane, or ethylene from  $H_2/CO$ , (2) production of propylene, alcohols, and  $\alpha$ -olefins from naphtha.

MINUTES  
ALABAMA ACADEMY OF SCIENCE  
ANNUAL BUSINESS MEETING  
Troy State University  
Montgomery Civic Center  
Montgomery, Alabama  
April 8, 1978

President James C. Wilkes called the meeting to order and asked the past president of the AJAS to come to the rostrum and introduce the newly elected officers of the AJAS. Cliff Hindman introduced President Michael Brummitt, Bradshaw High School; Vice-president Danny Milas, Gardendale High School; Secretary, Anne Smith, Robert E. Lee High School; and Treasurer, Lynda Ward, Cottonwood High School.

*REPORT OF THE SECRETARY: Dr. Ken Ottis*

Membership as of 3/30/78:	New Members	84
	Members Dropped	18
	Total Membership	607
Members Deceased in 1977:	Prof. R. V. Miles, past member of Board of Trustees	
	Dr. Walter B. Jones, past president, 1936-1937	
	Dr. Ralph Chermock, past president, 1955-1956	

A motion was made and seconded to accept the Report of the Secretary. This motion was passed.

*REPORT OF THE TREASURER: Dr. W. J. Wingo*

Bank Balance Oct. 22, 1977	\$ 5,684.75
Deposits End Oct. 1977	552.50
Dues ('77 & '78)	3,990.00
Journal	140.00
Jr. Symposium	1,000.00
Jr. Academy	5,960.00
	<u>\$17,327.75</u>
Checks Cleared 4/4/78	\$ 896.75
Bank Balance 4/4/78	16,431.00
Checks Outstanding	- 7,252.53
	<u>\$ 9,178.47</u>

Other Holdings:

1. Central Bank certificate of deposit will be worth, at maturity (April 15, 1978) \$ 8,811.84
2. Passbook savings account (April 6, 1978) \$ 4,449.10

## Minutes

A motion was made and seconded for the acceptance of the Treasurer's report. Motion was passed.

*REPORT OF PLACE OF MEETING COMMITTEE: Jack Brown, Chairman*

The University of North Alabama has confirmed the invitation to the Academy to have the 1979 annual meeting on the campus. President Guillot selected the dates of 29, 30, and 31 March 1979 and has asked Dr. Frank McArthur, Dean of the School of Arts and Sciences to serve as the chairman of the local arrangements committee.

Samford University has agreed to host the 1980 annual meeting. Dr. Ruric Wheeler, Vice-President for Academic Affairs, has indicated dates will be determined later.

*REPORT OF THE RESOLUTIONS COMMITTEE: Hoyt M. Kaylor*

WHEREAS the Alabama Academy of Science has held its 1978 annual meeting in Montgomery at the Montgomery Civic Center with Troy State University as our host, and has enjoyed the hospitality of the University, now therefore

BE IT RESOLVED that the Academy express its gratitude to Dr. Ralph Adams, President of Troy State University, and to the University for hosting this meeting. To Dr. Danice Costes, Chairman of our local hosts, and to the members of the local host committee, Mr. Eugene O'Masta, Miss Margaret Browder and Miss Susan Lockwood; to the faculty and staff of the Montgomery Civic Center; and to all of the many others who contributed to the success of this meeting, we, the members of the Academy, express our appreciation for their efforts on our behalf.

BE IT FURTHER RESOLVED that the Academy express its appreciation to our distinguished speaker of Friday evening, Dr. Edward Teller, and to Dr. Kenneth R. Turner for their presentations to the Academy.

BE IT FURTHER RESOLVED that the Academy express its appreciation to those who retire from leadership in the Academy this year, and especially to Dr. James C. Wilkes, President, and to Dr. William J. Wingo, Treasurer.

WHEREAS the Alabama Academy of Science has lost one of its distinguished members through the death of Dr. Walter B. Jones and

WHEREAS Dr. Jones served the Academy as President and as a member of the Board of Trustees and

WHEREAS Dr. Jones directed the Alabama State Geological Survey for many years, now therefore

BE IT RESOLVED that the Academy extend its sympathy to the family of Dr. Jones and

BE IT FURTHER RESOLVED that an appropriate letter together with a copy of this resolution be sent by the Secretary of the Academy to the family of Dr. Jones.

## Minutes

WHEREAS the Academy has lost one of its past presidents through the death of Dr. Ralph Chermock and

WHEREAS Dr. Chermock was a capable educator and a developer of young scientists in Alabama during his tenure at the University of Alabama where he served as Chairman of the Department of Biology, now therefore

BE IT RESOLVED that the Academy extend its sympathy to the family of Dr. Chermock and

BE IT FURTHER RESOLVED that the Secretary transmit an appropriate letter with a copy of this resolution to Dr. Chermock's family.

WHEREAS the Academy has lost one of its long-time members through the death of Dr. R. V. Miles, Jr. and

WHEREAS Dr. Miles, in addition to his dedicated membership, served the Academy as a member of its Board of Trustees, now therefore

BE IT RESOLVED that the Academy extend its sympathy to the family of Dr. Miles and

BE IT FURTHER RESOLVED that an appropriate letter with a copy of this resolution be sent to the family of Dr. Miles by the Secretary of the Academy.

It is hereby moved by the Committee on Resolutions that the above be accepted and entered in the Minutes of the Academy.

The motion was seconded and passed.

*REPORT OF THE AUDITORS: Senior Academy, Dan C. Holliman and Paul C. Bailey*

RE: Audit 1977-78

On this date we have examined the records of the Treasurer of the Alabama Academy of Science and have found them to be in order.

This is in accordance with the By-Laws of the Alabama Academy of Science and pursuant to the request from the Chairman of the Executive Committee.

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Paul C. Bailey  
Birmingham-Southern College

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Dan C. Holliman  
Birmingham-Southern College

A motion was made and seconded to accept the auditor's report. Motion was passed.

## Minutes

*REPORT OF THE AUDITORS: Junior Academy, Thomas Cochis*

No report.

*REPORT OF THE RESEARCH COMMITTEE: Jack H. Moore*

Two research grants were awarded to undergraduate students:

Jeffrey Donnellan  
Department of Geology  
Auburn University

"Fossil Cycadeoilalean Fructifications from the Cretaceous of Alabama." \$200.00. Supervising Professor: Dr. Ruth Stockey.

Ellen Evans

Department of History  
Auburn University

"The Diplomatic Career of Bernardino de Mendoza in England 1578-1584." \$200.00. Supervising Professor: Dr. R. Glenn Eaves.

The Senior Academy annually gives \$150.00 to the Junior Academy for research grants to secondary school students. This year \$277.00 was available from AAAS for Junior Academy research grants. Secondary school students receiving research grants from these funds were:

Stephen Heimborg

Randolph School  
Huntsville, Alabama

Supervising Teacher: Julia Snyder  
Title: Hydrogen, Fuel of the Future  
Amount of Grant: \$100.00 from AAAS

John Pippin

Selma High School

Supervising Teacher: John Johnson Jr.  
Title: Acoustic Efficiency of Phase Inversion Enclosures  
Amount of Grant: \$75.00 from Senior Academy

Kim Rachmeler

Randolph School  
Huntsville, Alabama

Supervising Teacher: Julia Snyder  
Title: Analysis & Growth of Crystals  
Amount of Grant: \$100.00 (\$50.00 Senior Academy, \$50.00 AAAS)

Dale Schultz

Randolph School  
Huntsville, Alabama

Supervising Teacher: Julia Snyder  
Title: Design & Construction of a Gamma Ray Photo Cell  
Amount of Grant: \$25.00 for Literature Search from Senior Academy

A. Tillotson

Robert E. Lee High School  
Montgomery, Alabama

## Minutes

Supervising Teacher: Billy Sanders  
Title: Radiation Field Photography and the Kirlian Effect  
Amount of Grant: \$127.00 from AAAS

In addition to research grants, the Senior Academy provided funds to five graduate students to attend this meeting to present papers. Each student received a grant of \$50.00 for this purpose from the Senior Academy.

A motion was made and seconded to accept the report of the Research Committee. Motion was passed.

*REPORT OF THE NOMINATING COMMITTEE: Reuben B. Boozer*

### Nominations:

President--William F. Arendale, UAH  
First Vice-president--Jack H. Moore, UNA  
Second Vice-president--Geraldine Emerson, UAB  
Treasurer--Billy Helms UAT ('81)

### Board of Trustees:

Samuel Barker, UAB ('81)  
Joe C. Thomas, UNA ('81)  
H. A. Henderson, TVA ('81)  
Elroy Curl, AU ('81)

Dr. Carmichael moved that nominations be closed. The motion was seconded and passed.

President Wilkes declared the report of the Nominating Committee be accepted and the nominees elected by unanimous consent.

*REPORT OF THE COORDINATOR, REGIONAL SCIENCE FAIRS: Rosemary Crawford*

The Finalists attending the International Science and Engineering Fair from their respective regions are:

Central Region Samford University	Tammi Tidwell Glenn Brock
Eastern Region Auburn University	Mike B. Halpin John C. Pippin
Mobile Region Spring Hill College	Stephanie Pierce Mark Delfunt
Northeastern Region Jacksonville St. Univ.	James Thomas Duke Scott Paul Schablow
North Region Univ. of Ala., Huntsville	Janine Askins Carl Powe, III
Western Region Univ. of Alabama	Scott Cross Scott W. Blume

## Minutes

Congratulations to all of you for winning in your regions.

A motion was made to accept Mrs. Crawford's report. The motion was seconded. Motion was passed.

### *REPORT OF THE GORGAS SCHOLARSHIP FOUNDATION: L. S. Hazelgrove*

The rankings were established by a panel of judges consisting of department heads, deans, and professors from many of the leading Universities and Industries in Alabama.

Dr. Levin S. Hazelgrove, Professor of Chemistry, Samford University, was Chairman of the Judges Committee.

Winners and alternates in the Gorgas Contests receive offers of tuition scholarships to colleges and universities in Alabama for the study of science. The Gorgas Foundation is named for General William Crawford Gorgas, the Alabama physician who conquered yellow fever in the Panama Canal Zone while serving as Surgeon General in the U.S. Army. The purposes of the Foundation are to promote interest in science and to aid in the education of promising students.

The Gorgas Foundation announced today the rankings of the finalists in the 1978 Alabama Science Talent Search. The search was held at the meeting of the Alabama Academy of Science at the Civic Center, Montgomery, Alabama.

The winner of the cash award was Karen J. Askins, 11209 Woodcrest Drive, Huntsville, Alabama from V. I. Grissom High School. Teacher: Mrs. Roberta A. Hill.

Alternates are:

1st. James F. Byrd, 1538 Marlowe Drive, Montgomery, Ala. from G. W. Carver High School. Teacher: Mrs. Mildred M. Hardy.

2nd. Amelia A. Morris, Rt. 1, Box 94C, Childersburg, Ala. from Childersburg High School. Teacher: Miss Dean Ingram.

3rd. Marvin M. Smith, 1713 3rd Place S.W., Birmingham, Ala. from West End High School. Teacher: Miss Mary E. Haffing.

4th. Edward M. Holliday, 2001 Willis Road, Huntsville, Ala. from Huntsville High School. Teacher: Mrs. Dorothy Dale.

5th. Teresa A. McDonald, 2220 Circle Drive, Birmingham, Ala. from Minor High School. Teacher: Charlotte Hamilton and Anna Vacca.

6th. Yvonne M. Wood, 9 Hedgewood Drive, Birmingham, Ala. from Minor High School. Teacher: Charlotte Hamilton and Anna Vacca.

### *REPORT OF AJAS & JSJS: James D. Walker*

The activities of the year officially began with the Fall Planning Meeting, which was held in Birmingham in early October, with all regions represented. Business was focused on discussions of the proposed budget, and details of the paper competitions and annual meeting.



## Minutes

The next major event for AJAS was the state-wide paper competition held at UBA, February 18, in which thirty-six papers were presented. The winners, listed below, will participate in an all-expense paid trip to the National Junior Science and Humanities Symposium to be held at Monmouth College in New Jersey, May 17-20, 1978.

Scott Blume (Tuscaloosa High School)

"Detection of Chemical Mutagens and Potential Carcinogens Using *Salmonella typhimurium* as Test Organisms and Liver Microsomes for Metabolic Activation"

Hyung Mi Kim (Bradshaw High School, Florence)

"Jensen's Controversial Theories"

Amy Morris (Childersburg High School)

"The Generation and Analysis of Alterations of the Snowflake Curve and Their Projections in N Dimensions"

Amy's paper was selected to be presented at the National Symposium.

Carl Walker (Donoho High School, Anniston)

"Photochemistry of Vision"

Lynda Ward (Cottonwood High School)

"Deactivation of a Bacterial Virus"

Orrin Carr (Randolph High School, Huntsville)--Alternate

"Compression of Soils"

Carl Powe (Randolph High School)

"Holography Microscopy"

Selected to be the recipient of the free trip to tour the Bell Telephone Labs in New Jersey, also scheduled for late May.

The official representative of the Alabama Region of JSHS will be Mr. Joseph Smith of Jacksonville State University, and Counselor of the Northeast Region. Other adults to attend the National Symposium are:

*The Outstanding Region in 1977-78--Northeast Region; Mr. Joseph Smith, Counselor*

*The Outstanding Science Teacher in 1977-78--Mrs. Mabel Phillips, Parker High School, Birmingham*

*The Henry Walker Memorial Scholarship--Thomas James of Tuskegee Institute High School was selected to receive this \$500.00 scholarship; Canh Viet Le, also of Tuskegee, and Charles Barnett, Phillips High School, near Bear Creek, Alabama, were second and third choices. Following the selection of Thomas James as the recipient, the selection committee was informed that he had just recently been admitted to MIT, so the scholarship award will be given to Canh Viet Le upon his enrollment in a college or university in Alabama.*

## Minutes

*AAAS Subscription Award*--Tim Bassett, Childersburg High School.

*Student Research Grants*

Dale Schultz (Randolph High School). \$100.00 from AAAS funds.

John Pippin (Selma High School). \$75.00.

Kim Rachmeler (Randolph High School). \$50.00 from AAS funds and \$50.00 from AAAS funds.

Stephen Heimburg (Randolph High School). \$100.00 from AAAS funds.

Antwane A. Tillotson (Robert E. Lee, Montgomery). \$127.00 from AAAS funds.

Mrs. Mable Phillips (Parker High School, Birmingham), who was selected to be the recipient of a special invitation from the National Office to minority teachers in inner-city schools;

Miss Dean Ingram (Childersburg High School), who was invited to attend at her own expense; and,

Mrs. Phyllis Walch (Cottonwood High School). Mrs. Walch, a highly successful teacher and enthusiastic supporter of the AJAS program during her six years at Cottonwood, is retiring from active teaching at the end of this year. In recognition of her work in AJAS, and the outstanding achievements of her students, funds to support her participation in the National Symposium were solicited from businesses in the Cottonwood-Dothan area.

The awards recognized publicly represent only a very few of the students and teachers in Alabama who have earned reputations of being outstanding in science. The vast majority of science teachers, although known locally to be unusually effective in the classroom, laboratory or field, have yet to become recognized across the state. A new AJAS project to start immediately will be an effort to bring together in a bound volume, the most effective classroom, laboratory, and field activities, methods and techniques, practiced by teachers in all regions in the state. The monies from the sale of this book or manual will be used to provide additional support of the AJAS program.

All AJAS officers, counselors and interested science teachers will be invited to participate in a brain-storming session to be scheduled in early May for the purpose of making plans to expand the AJAS-JSHS program next year. On the basis of the discussions generated a proposal for the expanded program, and its financial support, will be submitted to the National JSHS office in June. All officers and counselors will be notified of the exact time and place of the meeting.

*AJAS AWARDS: Faye Wells*

A \$50.00 research award to Michael Brummitt, Bradshaw High School. Given in memory of Mrs. Myrtle Alexander. Title: "Some Observed Effects of Sulphur Dioxide on Soybeans."

## Minutes

A one year subscription to Scientific Monthly and Science Newsletter to Tim Bassett, Childersburg High School from AAAS.

*\$500.00 Walker Scholarship:* 1st Place: Cahn Viet Le, Tuskegee Inst. High School  
1st Place Alternate: Charles E. Barnett, Phillips High School, Bear Creek, Alabama

*Outstanding Region Award:* Northeast Region, Joe Smith, Regional Counselor

*Outstanding Teacher Award:* Mrs. Mabel Phillips, Parker High School, Birmingham, Alabama

A motion was made to accept the report. The motion was seconded and passed.

### *OLD BUSINESS:*

President Wilkes reported that Dr. Donald Davis of the Botany Department at Auburn University has been elected a Fellow in the American Association for Advancement of Sciences. Dr. Davis hereby becomes, also, a Fellow of the Alabama Academy of Science.

Eugene Omasta, in charge of Local Arrangements for the Junior Academy, reported that 325 members of AJAS attended the River Boat Banquet and Dance. He added that a total of 340 Junior Academy members were in attendance at this Annual Meeting and that 315 attended the joint banquet with the Senior Academy.

Gene tendered his appreciation for the excellent cooperation he received from the group throughout this annual meeting.

### *NEW BUSINESS:*

Dr. Wilkes introduced the new President, Dr. William Arendale and thanked all of his officers for their loyal support during his year in office.

Dr. Arendale complimented Dr. Wilkes on the good work his administration had done the past year. Bill said he was aware that his administration was following some past progressive leadership and he hoped that we could now keep the momentum rolling and have another good year for the Alabama Academy of Science.

There being no further business to conduct, the 55th Annual Meeting of the Alabama Academy of Science was adjourned.

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ORBITS, THE CALCULATOR, AND THE NON-CALCULUS  
PHYSICS LABORATORY

David R. Curott

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Florence, Alabama 35630*

*Abstract.* Students in a non-calculus based physics laboratory "solve" the problem of a satellite in orbit about the earth, using their pocket calculators. In order to increase the speed of computation, the same computational steps are then programmed on a full size computer and the printouts of position are plotted in laboratory for a visual presentation. This "Play Houston Control" project strengthens their confidence in being able to handle involved dynamical situations, and it fosters a much needed understanding of the usefulness and limitations of the digital computer. Colleagues are encouraged to exploit the recent population explosion of pocket calculators.

INTRODUCTION

Pocket calculators are not required for our non-calculus based General Physics course; however, this year all 42 students had them! The stage was thus set for a pedagogical use of these ubiquitous devices to counter the off-held impression of these students that interesting "real life" situations with non-constant forces were solvable only by the technical (calculus based) physics students. I submit that a more important result was an understanding gained regarding the operation and limitations of large scale computers.

SYLLABUS

Using the calculation of the orbit of an artificial satellite as our nominal objective, the students helped me break the dynamical problem into computational steps amenable to pocket calculator solution. Once the calculational algorithm (see Appendix I) was developed, the students, in groups of about three, calculated the approximate position and velocity at  $\Delta t$  seconds after the initial (given) position and velocity. They realized the approximation would be better for smaller  $\Delta t$ 's. Each group began with a different set of initial conditions. Once the second position and velocity were determined, the process was repeated (iteration) to obtain the position  $\Delta t$  seconds later, i.e.: at  $t = 2\Delta t$ ; then again at  $t = 3\Delta t$ , and so forth.

The groups took from 15 to 45 minutes to complete *each* iteration cycle (that is, obtain one new position and velocity) so it became apparent to them that only a small segment of the orbit would be obtained

after many hours of computation. They were impressed that they could "in principle" complete such an interesting problem; however, a graph of a complete orbit seemed outside their grasp due to time limitations. At this point it was very appropriate to introduce the large scale digital computer to them, translate their manual computation steps into FORTRAN instructions (Appendix II), and run the orbit calculation for them to obtain "complete" solutions in a fraction of a minute of machine computation time. Each person received a hard copy of the results (positions, etc.) and they plotted each orbit.

#### ADVANTAGES

(1) Non-calculus students realize that "real" problems with varying forces are amenable to their analysis.

(2) They are introduced to computer analysis and the elements of a computer language (Fortran), and observe first hand the tremendous speed of the computer vs manual calculation. Most of these students would never otherwise have an occasion to familiarize themselves with a computer and experience its strengths and weaknesses. This is pathetic when one realizes many of them go on to positions of power and influence as doctors, lawyers, politicians, architects, etc.

(3) Of course the students have a better acquaintance with orbital dynamics; however, that is not a major objective, only a minor spinoff benefit.

*Acknowledgement.* I wish to acknowledge the support and encouragement of my department chairman, D. Lee Allison; and thank the UNA computer facility for its help. Most of all the interest and enthusiasm of my students have made teaching a joy!

#### APPENDIX I

*Orbit Algorithm Algebra:* Given the initial position coordinates  $x_1$  and  $y_1$  and the initial velocities  $v_{x1}$  and  $v_{y1}$  and the geologic constant  $GM = 3.084 \times 10^{14} \text{ m}^3\text{s}^{-2}$ ; the satellite moves to  $(x_2, y_2)$  after time  $\Delta t$ . If  $\Delta t$  is small, then the change in velocity and position components is to first order:

$$\Delta v_x = a_x \Delta t \quad a_x = F_{x/m} = \frac{-GM}{r^2} \cos \phi$$

$$\Delta v_y = a_y \Delta t \quad a_y = F_{y/m} = \frac{-GM}{r^2} \sin \phi$$

$$\Delta x = v_x \Delta t + (1/2) a_x (\Delta t)^2$$

$$\Delta y = v_y \Delta t + (1/2) a_y (\Delta t)^2$$

Thus we can find the second position and speed:

$$x_2 = x_1 + \Delta x$$

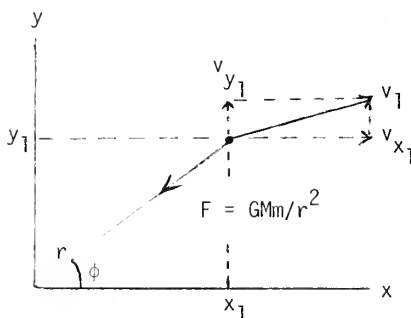
$$y_2 = y_1 + \Delta y$$



# Non-Calculus Physics Laboratory

$$v_{x2} = v_{x1} + \Delta v_x \quad v_{y2} = v_{y1} + \Delta v_y$$

Iteration produces successive positions.



TABULAR ALGORITHM for pocket calculator computation: (using  $\Delta t = 100.$  sec).

The student fills in the first column, then the second, and so forth.

			-----ITERATIONS-----			
Variable	(Units)	ALGORITHM	First	Second	Third	Fourth
t	(sec)	t + Δt	0.*	100.	200.	300.
x	(10 <sup>6</sup> m)	x + Δx	0.*	1.00	1.99	2.97
y	(10 <sup>6</sup> m)	y + Δy	7.41*	7.37	7.34	7.22
v <sub>x</sub>	(m/s)	v <sub>x</sub> + Δv <sub>x</sub>	10000.*	9904.	9902.	9722.
v <sub>y</sub>	(m/s)	v <sub>y</sub> + Δv <sub>y</sub>	0.*	-714.	-894.	-1558.
r	(10 <sup>6</sup> m)	(x <sup>2</sup> + y <sup>2</sup> ) <sup>1/2</sup>	7.41	7.44	7.61	7.81
φ	(degrees)	tan <sup>-1</sup> (y/x)	90.	82.	75.	68.
g	(ms <sup>-2</sup> )	GM/r <sup>2</sup>	7.25	7.20	6.88	ETC.
a <sub>x</sub>	(ms <sup>-2</sup> )	-gx/r	0.	-.10	-1.80	
a <sub>y</sub>	(ms <sup>-2</sup> )	-gy/r	-7.25	-7.14	-6.64	
Δv <sub>x</sub>	(ms <sup>-1</sup> )	a <sub>x</sub> Δt	0.	-96.5	-180.	
Δv <sub>y</sub>	(ms <sup>-1</sup> )	a <sub>y</sub> Δt	-725.	-714.	-664.	
Δx	(10 <sup>6</sup> m)	v <sub>x</sub> Δt+(.5)a <sub>x</sub> Δt <sup>2</sup>	1.00	0.990	0.981	
Δy	(10 <sup>6</sup> m)	v <sub>y</sub> Δt+(.5)a <sub>y</sub> Δt <sup>2</sup>	-.036	-.035	-.123	

\* initial conditions

## APPENDIX II

A portion of the FORTRAN program† to illustrate the parallel with the calculator algorithm:

```

AX = - GM * X(K) / (R(K)**3)
AY = - GM * Y(K) / (R(K)**3)
DVX = AX * DT
DVG = AY * DT
DX = VX(K) * DT + AX * DT*DT/ 2.
DY = VY(K) * DT + AY * DT*DT/ 2.
L = K + 1
X(L) = X(K) + DX
Y(L) = Y(K) + DY
VX(L) = VX(K) + DVX
VY(L) = VY(K) + DVG
T(L) = T(K) + DT
R(L) = SQRT(X(L)**2 + Y(L)**2)
G(L) = GM/ (R(L)**2)
etc.

```

---

†The full program is available from the author.

CURRENT STATUS OF THE RED HILLS SALAMANDER,  
*Phaeognathus hubrichti* HIGHTON, AND  
FACTORS AFFECTING ITS DISTRIBUTION<sup>1</sup>

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Department of Zoology-Entomology  
School of Agriculture and Agricultural Experiment Station  
Auburn University  
Auburn, Alabama 36830

INTRODUCTION

The Red Hills salamander, *Phaeognathus hubrichti* Highton, was described in 1961. It occurs only in a relatively small area in southern Alabama. Based on a study of the salamander and its habitats conducted between November, 1970 and April, 1972, Jordan and Mount (4) stated that certain forestry practices were damaging or destroying the habitats of *P. hubrichti*. They stated further that the species "should be placed on the national list of threatened wildlife, and that measures should be taken to insure its continued survival."

On March 6 and 7, 1975, participants at a symposium held in Tuscaloosa, Alabama, under the co-sponsorship of the Alabama Department of Conservation and Natural Resources and the University of Alabama Museum of Natural History, compiled a list of threatened and endangered plants and animals of Alabama. The list included *P. hubrichti* as an endangered species (5). On October 1, 1975, the U.S. Fish and Wildlife Service proposed that the species be considered for endangered status under the Endangered Species Conservation Act of 1973 (*Fed. Regist.* 40:191:45175).

Following a period of public comment and a meeting of federal and state officials and concerned citizens, the U.S. Fish and Wildlife Service employed the senior author to undertake a detailed investigation of *P. hubrichti* to acquire information that would assist the Secretary of the Interior in making a final judgement in the case. Specifically, the study was to provide the following information: 1) the range of the animal, 2) the distribution of the form within its range, 3) the limiting factors associated with its distribution, 4) the effects of various forestry practices on the animal, 5) the total acreage of suitable habitat remaining, and, if applicable, 6) a delineation of areas that might be considered "critical habitat," as defined in the *Federal Register* 40:78:17764-17765.

---

<sup>1</sup>Manuscript received 2 March 1978; accepted 31 May 1978.

<sup>2</sup>Current Address: Dept. of Life Sciences, Indiana State University, Terre Haute, Indiana 47809.

The results of the investigation, conducted between January 19 and April 2, 1976, and the actions that followed are reported herein. Specific locality data, for the most part, are not included because of the possibility of their being misused. Persons or agencies having a legitimate need for such data should contact the Southeastern Regional Endangered Species Office, U.S.F.W.S., 17 Executive Park Dr., Atlanta, Georgia 30329.

The success of this investigation was due in considerable measure to the excellent cooperation received from virtually all of the owners, or representatives of the owners, of large tracts of land within the range of *P. hubrichti*. The authors gratefully acknowledge this cooperation along with the assistance of Drs. James L. Dobie and George W. Folkerts, who kindly read the manuscript and offered numerous suggestions for improving it.

## METHODS

Intensive field investigations were conducted during the first eight weeks of the study (19 January-12 March, 1976). With the aid of information published previously, 7 1/2 min. U.S.G.S. quadrangle maps, county geological maps, and landowners, habitats within the known range of *P. hubrichti* that were believed to be capable of supporting healthy populations of the animal were located and visited. Also located and visited were seemingly suitable habitats situated outside the known range and habitats within the known range that apparently had been substantially damaged or rendered unsuitable by clear-cutting of forests, mechanical site-preparation, or other forestry practices (4).

Altogether, 145 sites were visited. At each site, notes were made on the conditions of the habitat, and a search was made for evidence of the presence of *P. hubrichti*. Most observations were made during daylight, when the salamander is usually underground. The animal's presence is revealed, however, by its burrows, the openings of which are characteristic (6, 7). On some occasions, burrows apparently belonging to *P. hubrichti* were excavated in an attempt to determine the occupant with certainty. These excavations were made when burrows were scarce, were located in apparently marginal habitat, or were near the periphery of the known range.

The burrows of the salamander could usually be located within a few minutes when the animals were present. The time spent at each site ranged from 5 to 240 minutes per visit, and averaged about 50 minutes. The sites visited were plotted precisely in the field, and notes were made on relative population densities of the salamander, as nearly as could be determined by the numbers of burrows found per unit of area.

After the field work was completed, the areas inhabited by *P. hubrichti* were outlined, with aid of contour intervals, as accurately as possible on the quadrangle maps. The size of the inhabited areas was then determined using a polar planimeter.

## RESULTS AND DISCUSSIONS

### Geographic Range and General Nature of Optimal Habitat

Of the 145 sites visited, 73 were definitely inhabited by *P. hubrichti*. Schwaner and Mount (6) contended that *P. hubrichti* is restricted to the Tallahatta and Hatchetigbee formations between the Conecuh and Alabama rivers, in a 5-county area of central southern Alabama. They and others (1, 3, 7) noted that optimum habitat consists of wooded mesic ravines dominated by hardwood trees. Jordan (3) emphasized the importance of an outcropping or an underlying layer of siltstone as a habitat requisite, noting that the material is remarkable in its capacity to retain moisture, and that burrows of *P. hubrichti*, or branches of the burrows, invariably extend into natural cavities within the siltstone.

The present study confirmed, for the most part, the contentions of earlier workers relative to optimum habitat constitution and supported that of Schwaner and Mount (6) with respect to range limits. The Tallahatta and Hatchetigbee formations both extend east of the Conecuh River and west of the Alabama River. Visits to eight sites with seemingly optimal habitat in the easterly extensions and to seven such sites in the westerly extensions revealed no evidence of *P. hubrichti*.

In general, the greatest population densities of *P. hubrichti*, and, in relatively undisturbed situations, the most favorable habitat conditions for the salamander are associated with the sides of high bluffs and slopes of deep ravines in the Tallahatta Formation. The bluffs tend to be associated with rivers, large creeks, and their major tributaries. The streams include Three Mile Creek, Patsaliga Creek, Pigeon Creek, Persimmon Creek, Sepulga River, Big Flat Creek, and Alabama River. The hardwood-forested bluffsides and ravine slopes along the northern edge of the Tallahatta provide particularly favorable habitat and support correspondingly dense populations. The salamander is usually absent along the less mature drainages on the southern periphery of the formation. These drainages have cut into the Tallahatta Formation, but in most cases the formation is not well exposed on the bordering slopes. Also, such drainages have not worked their way into the formation sufficiently far northward to intersect the older drainages, whose bordering slopes support *P. hubrichti* populations. Exceptional are the bluffs along Brushy Creek, one of the headwaters of Limestone Creek in Monroe County, where an isolated group occurs.

Along the southern side of Big Flat Creek in Monroe County are three isolated exposures of the Tallahatta Formation which seemingly afford good habitat for *P. hubrichti*. The westernmost of these supports a population of the salamander, but the other two, despite the apparent suitability of their character, do not.

On the Covington and Crenshaw county geologic maps, the Hatchetigbee and Tallahatta formations are undifferentiated, whereas on the Butler, Conecuh, and Monroe county maps, they are differentiated. Our

observations indicate that *P. hubrichti* is much less likely to occur in the Hatchetigbee Formation than in the Tallahatta. In fact, in every instance where the salamander was clearly found within the former, exposures of the latter occurred in relatively close proximity.

Along the eastern sides of Patsaliga Creek in Covington County and Pigeon Creek in Butler County north of State Hwy. 106, are slopes that support *P. hubrichti* populations. These slopes are not included within either the Tallahatta or Hatchetigbee formations on the maps, but they are, as nearly as we could determine, indistinguishable from many in the Tallahatta Formation and probably represent isolated exposures thereof.

In one area, *P. hubrichti* populations were associated with a soil type that may not belong to either the Tallahatta or Hatchetigbee formation. These were found at the mouths of each of two adjacent ravines on Brushy Creek, in Monroe County. The uppermost stratum of mineral soil at the sites is a reddish clay containing large gravel. The stratum immediately beneath, in which the salamander's burrows were found, is a reddish clay loam with no gravel. Gray clay, more nearly typical of the Tallahatta Formation, occurs in the nearby stream bed. The reddish soils may belong to the Lisbon Formation, which overlays the Tallahatta in that area.

#### Distribution in Relation to Slope and Moisture

Valentine (7) noted that the most obvious burrows of *P. hubrichti* were on earthen banks too steep to collect litter. However, Schwaner and Mount (6) found that in some instances, burrow openings were on nearly level ground. The most favorable situations for the occurrence of *P. hubrichti*, as evidenced by their burrows, are sides of bluffs and ravines that have generally moderate slopes but variable microtopography.

High, vertical to near-vertical bluffs occur throughout the range of the species, especially along the Alabama River, with some rising as high as 30-35 m above their bases. The upper portions of these bluffs are constantly sloughing off, however, tending to prevent the salamanders from establishing and maintaining their burrow systems. This sloughing contributes to the buildup of a talus layer at the bases of the bluffs, burying the otherwise suitable habitat at the lower levels. Thus, at such sites, population densities are often lower than might be anticipated.

Some sites with relatively gentle relief support Red Hills salamander populations, but densities are generally low. In such places, the burrow openings are found most frequently on the few spots that have at least some slope. Such sites occur around the bases of large trees, or consist of mounds of soil that have persisted and weathered after having been pulled up by an uprooted tree.

In some cases *P. hubrichti* may be absent on south-facing slopes having seemingly adequate forest cover. This may be the result of inadequate moisture near the surface. The salamander may also be absent, or present in low population densities, near the ends of long, narrow,

finger-like ridges that project from major ridge systems. Ridges such as these are especially common east and west of the upper reaches of Big Flat Creek in Monroe County. Low population levels are also found on the narrow, isolated ridges in the "Potato Hills" region in Monroe County, southwest of Vredenburgh. In this area the slopes of the ridges are relatively dry. When burrows are found on these sites in dry weather, the first few centimeters of the burrow may be hard and dry, but the inner recesses are always moist. The entrances of burrows in these dry situations still show the typical smooth, oval characteristics. A close examination of the entrance reveals that the soil has been dampened and rubbed slick, but later has dried and hardened.

#### Effects of Various Forestry Practices on Populations of *P. hubrichti*

Jordan and Mount (4) stated that populations of *P. hubrichti* often survive selective cutting of the forests, but that clear-cutting eliminates populations "on most, if not all of the clear-cut sites." They also stated that mechanical site-preparation preparatory to planting pines magnifies the adverse effect of clear-cutting on the forest floor fauna.

The findings of the present study agree generally with those of Jordan and Mount (4). In no instance where 100% of the forest cover had been removed were any *P. hubrichti* found. The effects of selective cutting depended on the amount of the canopy removed, the slope, and on moisture conditions. On several south-facing slopes, populations had been completely eliminated by heavy cutting. Conversely, most heavily cut north-facing slopes continued to support some salamanders. These slopes were typically those that featured distinct rock bluffs, even low ones. Along the bases of such bluffs, occasional seepages often provided sufficient moisture to support small, isolated remnants of the population. On some heavily cut north-facing slopes, no more than one active burrow per 30 m of linear distance was found.

The question arises as to whether a species that produces only four to nine eggs per year (Brandon, 1; pers. observation) and is as limited in its vagility as is *P. hubrichti* (3) can successfully repopulate an area when its numbers have been reduced to extremely low levels. In this regard, the following observations may be elucidative. Small, isolated populations were found on several slopes that had been intensively cut, but not clear-cut, as long as ten years ago. In most such cases, the population levels remain low. An exception is the case of a severely cut, north-facing slope in Monroe County on which the population is relatively dense. The site is a moist, terraced slope which lacks a distinct rock bluff. In 1973 the forests above and below the slope were clear-cut, and at least 90% of the canopy was removed from the slope itself. The soil on the slope was not severely disturbed, and moisture conditions seemed favorable. At the time of the observation, hardwood stumps had sprouted, supplying some protective shade.

East of Interstate Hwy. 65, the majority of the habitat of *P. hubrichti* has been damaged or destroyed by forestry operations. Some areas, not contiguous with areas presently inhabited by the salamander,



may have supported populations in the recent past but are no longer suitable. Examples are the slopes around Pigeon Creek Fire Tower, Butler Co., T8N, R15E, portions of secs. 10, 14, 15, and 16, and the ridge slopes north of Butler County Rt. 45 (T7N, R14E, portions of secs. 20 and 29). Habitats remaining suitable for *P. hubrichti* east of I-65 include the type locality and some sites along the same slope east and west of the type locality, an area immediately east of Pigeon Creek, Butler Co., and a slope on the southern border of a small stream south of Oaky Streak Church, Covington County. Also situated east of I-65, and adjacent to some of the clear-cut areas, are some small, relatively undisturbed patches of suitable habitat having relatively dense *P. hubrichti* populations. West of I-65 are several large tracts in which *P. hubrichti* habitat has been destroyed or heavily damaged, but the majority of the habitat there remains suitable at the time of this study.

Erosion caused by forestry operations above the slopes inhabited by *P. hubrichti*, and on the slopes themselves, was observed occasionally and apparently is detrimental to the salamander. Such erosion, however, seemed no more detrimental than the natural sloughing that occurs on the steeper bluffs within the animal's range.

#### Current Status, Trends, and Projections

Jordan and Mount (4) estimated that 63,000 acres (ca. 25,500 ha) of suitable habitat remained within the range of *P. hubrichti*. Our estimate is 54,900 acres (22,200 ha). Of the latter, 3,075 acres (ca. 1,245 ha) has been affected detrimentally by forestry operations during the past decade, and the salamander populations thereon are small and irregularly distributed. At least 3,670 acres (1,485 ha), not included above, have supported populations of *P. hubrichti* that have been eliminated during the decade prior to January, 1976.

Jordan and Mount (4) estimated that paper companies own or control about 44% of the remaining habitat of *P. hubrichti* and "that a large portion, if not most of this habitat will be altered to the extent that it will be incapable of supporting the salamander if current trends continue." In the present study we noted that both corporate and individual landowners are increasingly reluctant to clear-cut ravine slopes and bluff-sides. Instead, most owners now tend to "mark-out" the steep to moderately steep hardwood dominated slopes, which include a substantial portion, if not a majority, of the salamander's suitable habitat. These are either selectively cut, or in some cases, left uncut. The extent of canopy removal where cutting is done varies considerably. Because of this and the variables already mentioned, the effects on resident populations of *P. hubrichti* on the "marked-out" slopes are correspondingly variable.

Several corporations holding substantial amounts of the available *P. hubrichti* habitat have indicated privately, or informally, that they will attempt to preserve the integrity of the habitat on their lands, and one corporation, International Paper Company, has issued a formal policy statement to that effect. The statement, issued in October, 1976, includes the following: (1) Clearcutting and mechanical site preparation will be prohibited on areas identified as supporting, or having the potential to support, colonies of the Red Hills salamander on Company land. (2) An appropriate buffer zone will be left on each side of the identified salamander habitat and only selective harvesting will be

## Red Hills Salamander

allowed in the buffer zone. (3) Road construction will be avoided on sites where the existence of the salamander is known. (4) Periodically, knowledgeable zoologists will be called on to "define the habitat and determine the population of the salamander" on Company land.

This policy has been implemented. In December, 1976, the junior author visited I.P.C.'s holdings in Monroe County and, together with company representatives, decided on areas to be marked-out and protected that were within the limits of the 1977-1978 cutting budget. It is anticipated that this procedure will be followed each time a new cutting budget is mapped. The actions of the I.P.C. are especially important as a contribution to the welfare of *P. hubrichti*. The company owns approximately 6,930 acres (ca. 2,810 ha), or 12.6% of the total habitat remaining. This is probably more than is owned by any other single landowner.

Jordan and Mount (4) indicated that all of the habitat of *P. hubrichti* was privately owned. The present survey revealed three sites with suitable habitat that are publicly owned. These are a bluff on the Lookout Hill Fire Tower property owned by the Alabama Forestry Commission; a small series of slopes at McDuffie's Landing, along the Alabama River; and a section of steep bluff at Haines Island Park, also along the Alabama River. All three are in Monroe County. The last two are managed by the U.S. Corps of Engineers. The total area of suitable habitat in these three places is about 150 acres (ca. 61 ha), some of which supports relatively dense populations of the salamander.

On April 10, 1976, the information reported herein was submitted to the U.S. Fish and Wildlife Service. On December 3, 1976, *P. hubrichti* was officially designated a threatened species at the federal level (*Fed. Regist.*, 41:234:53032-53034), and is thus protected under the provisions of the Endangered Species Conservation Act of 1973. Designation as "threatened" rather than "endangered," as had been proposed earlier, was based on a determination that the threat to the salamander is less severe than was earlier believed to be the case. With continuing cooperation among federal and state authorities and landowners in the area, there is good reason to believe that *P. hubrichti* will survive indefinitely as a member of Alabama's fascinating herpetofauna.

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## A PRECISION BETA IRRADIATOR<sup>1,2</sup>

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**Abstract.** A Lucite container and lead shield was designed and constructed to enclose an encapsulated strontium-90 source for use as an irradiator. A timing power driver was also designed and constructed to control and measure irradiation times. Specifications of the container and the theory of the timer and associated electronics are given. Total error of irradiation time is also given.

### INTRODUCTION

It is common to observe commercial Co-60 and some neutron irradiators in nuclear studies, however specific information on the design of beta irradiators is not easily accessible. Since 1950 when Fridell et al.<sup>1,2</sup> applied Sr-90 for eye disorders, beta sources in the form of Sr-90 have been used for many various applications.

The Nuclear Regulatory Commission has issued a contract to The University of Michigan for a two-year pilot study of the Health Physics Society's Standard, "Criteria for Testing Personnel Dosimetry Performance." The Health Physics standard requires, in addition to other x-ray, gamma and neutron sources, the use of a Sr-90 irradiator of film badges and thermoluminescent devices. Strontium-90 was chosen mainly due to the low dose rates of the other beta emitters such as uranium. The need for precisely reproducible dose rates (<1% variation) from a Sr-90 irradiator is required so that dosimetry can be performed accurately, and so that an operator of this irradiator is adequately protected. In designing and constructing the irradiator factors considered were: (1) precision electronic and mechanical systems, (2) reliability, and (3) ease of construction.

The Lucite container used to encapsulate the Sr-90 source was designed and constructed for rigidity, easy movement, radiation tightness, and relatively small dimensions. The size of the box was controlled by the type of Sr-90 source. The particular 40 mCi source was manufactured

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by New England Nuclear, model NB-1 therapy source. The therapy source was accurately calibrated by the National Bureau of Standards utilizing an extrapolation chamber. This measurement was duplicated at The University of Michigan with the source in the container. The error between the two measurements was  $< 0.1\%$ .

The timing power driver was designed and constructed compatible with TTL parameters. A hybrid relay and power solenoid were chosen so that delay time was small and maximum movement by the solenoid was obtained.

## DISCUSSION OF COMPONENTS

### Lucite Container

In order to establish parameters of the Lucite container the beta-ray energies from Sr-90 and Y-90 were considered. The average energy of the Sr-90 betas was 0.200 MeV and the maximum was 0.544 MeV. The average energy of the Y-90 betas was 0.931 MeV and the maximum was 2.245 MeV<sup>3</sup>. From beta spectroscopy, range relationships for betas in Lucite can be obtained. The amount of Lucite necessary to stop all of the most energetic betas is approximately 0.89 cm. This results in the usage of a standard Lucite plate 1.27 cm thick. Figure 1 illustrates the Lucite container.

As the betas slow down in traversing the Lucite bremsstrahlung occurs; consequently, the number of X rays produced must also be reduced. To accomplish this a 0.318 cm thick lead plate completely covered the container. The surface dose rate of the exposed source was  $1.4 \times 10^3$  Gy/hr ( $1.4 \times 10^5$  rads/hr). The dose rate at the door when the source was not exposed was 35.2 mGy/hr (35 mrad/hr). For this particular experiment the dosimeters were placed at 35 cm from the irradiator. The dose rates at this distance with and without the source exposed are  $9.3 \times 10^{-2}$  Gy/hr (9.3 rads/hr) and  $1.6 \times 10^{-2}$  mGy/hr (1.6 mrad/hr), respectively.

The irradiator is operated by automatically opening, with timing power driver, a radiation protection door in front of the Sr-90 source. The Lucite radiation door, 1.27 cm thick, was lined with 0.318 cm thick lead shielding. The door is raised very rapidly by solenoid action, and then free falls back to its protective position after the irradiation. Machined and polished surfaces were used to allow the door to free fall. The angle subtended by the door guide was measured to be  $34^\circ$  with respect to the center of the Sr-90 source.

### Timing Power Driver

To provide drive to the radiation door position solenoid, a timing power driver was designed and constructed. Table 1 gives the parts listing for the driver. Overall design characteristics included the following:

- (1) The timing section should be accurate to  $\pm 2\%$  of the least significant time increment.

## A Precision Beta Irradiator

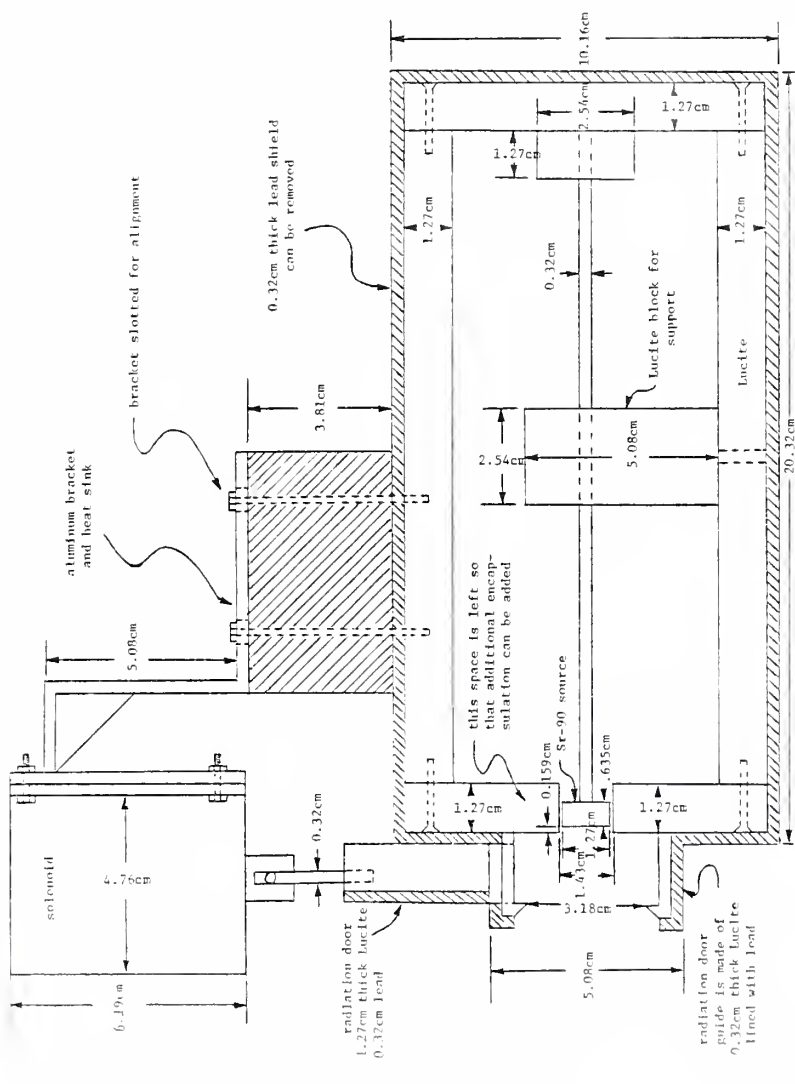


Table 1. Parts listing--timing power driver

Part Designation	Part Function	Part Number
CR1	Transient Suppressor	1N914
CR2-CR3	Power Supply Rectifier	GE512
D1-D4	Display, 7 segment	MAN-71
IC1	Oscillator	MX0-40
IC2-IC4	Binary Counter	7493
IC5-IC9	Decade Counter	7490
IC10	Divide by 12 Counter	7492
IC11-IC14	Decade Counter	7490
IC15	4 to 10 Decoder	7445
IC16-IC19	Comparator	7485
IC20-IC23	Inverter	7400
IC24	NAND/Inverter	7400
IC25-IC26	Display Digit Multiplexer	74153
IC27	BCD to 7 Segment Decoder	7447
K1	Lockout Relay	MR106-C
K2	Hybrid Relay	221A3-5D
LED1	Run/Stop Indicator	521-2942
LED2	Power-on Indicator	MV5054
Q1-Q4	Display Digit Driver	2N3906
Q5	Relay Driver	2N3906
R1-R4	Base Current Limit	330 $\Omega$ /4W
R5-R8	Pull-up	1200 $\Omega$ /4W
R9-R15	Segment Current Limit	LDP14-01
R16	Base Current Limit	560 $\Omega$ /4W
R17	LED1 Current Limit	100 $\Omega$ /4W
R18	LED2 Current Limit	100 $\Omega$ /4W
T1	Power Transformer	21F83
TS1-TS4	Thumbwheel Switch	SF-21

- (2) The driver portion should be capable of delivering sufficient power to drive the door position solenoid and at least one auxiliary power relay.
- (3) It is desired that the exposure time be operator selectable from minimum of 0.01 min. to maximum of 99.99 min.
- (4) The controls and displays of the timer should be easily accessible and easily understood by the operator.
- (5) The entire unit should be reliable and easily serviced.

Having laid the ground work, it is now possible to proceed with a discussion of the block diagram of the timing power driver design. Figure 2 illustrates a timing power design broken into functional blocks. A brief description of each block follows.



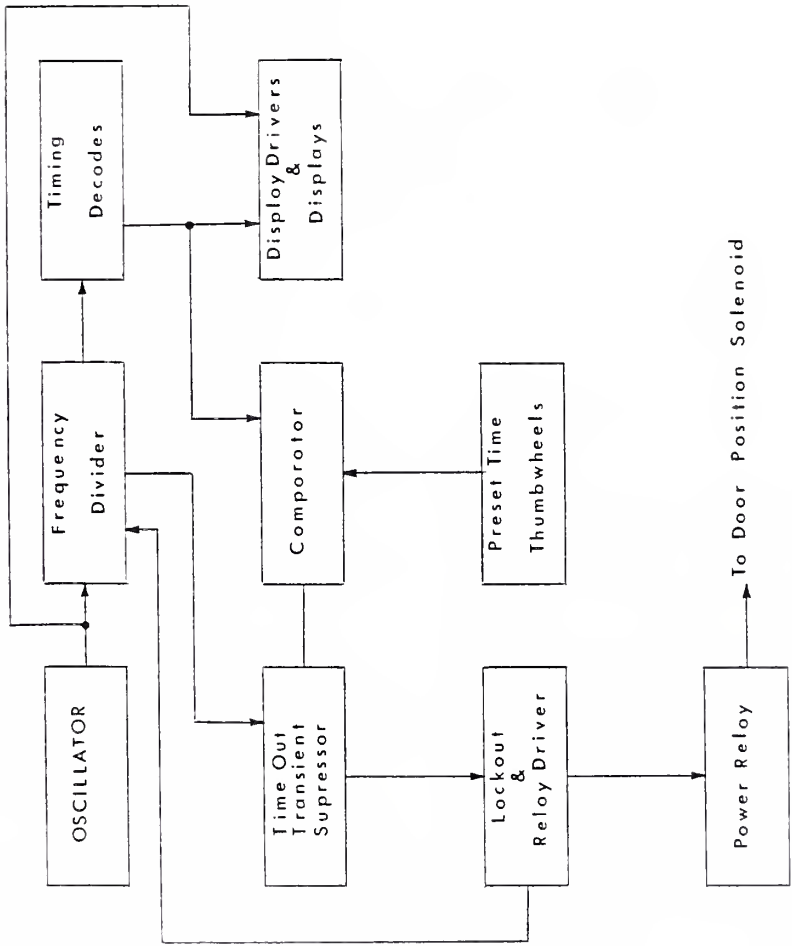


Figure 2. The timing power driver block diagram

### Oscillator

The oscillator, shown in Fig. 3, is a high precision, free running, crystal controlled unit which is contained in a 14 pin DIP style package. The unit chosen provides a 1 MHz ( $\pm 0.01\%$ ) square wave of approximately 50% duty cycle and requires only a few milliseconds to start after power application. The output is fully TTL compatible and is rated for a fan-out of 10.

### Frequency Divider

Since the specifications at The University of Michigan call for a minimum time increment of 0.01 min., the frequencies divider (IC5-IC10) must accept the 1 MHz input from the oscillator stage and output a 1 2/3 Hz signal. The period of a 1 2/3 Hz signal is given by

$$T = 1/f = \frac{1}{1 \frac{2}{3}} = 0.6 \text{ sec} = 0.01 \text{ min.} \quad (1)$$

In order to obtain a 1 2/3 Hz output from a 1 MHz input the frequency divider must divide by a constant D, such that

$$D = \frac{1,000,000}{1 \frac{2}{3}} = 600,000. \quad (2)$$

### Timing Decades

The timing decades section (IC11-IC14), shown in Fig. 4, is the actual "workhorse" of the circuit, in that it provides elapsed time information to both the display drivers and the comparator sections. The least significant digit in this section increments every 0.01 min.

### Display Drivers and Display

The display drivers (IC2-IC4, IC15, IC25-IC27, Q1-Q4), shown in Fig. 5, accept information from the timing decades, which is BCD encoded, and provides the decoding necessary to drive the seven segment LED displays (D1-D4). This is schematically shown in Fig. 6. In addition, the circuit provides for digit multiplexing which reduces component count and, more importantly, power consumption.

### Comparator

The comparator (IC16-IC19) accepts the elapsed time input from the timing decades (IC11-IC14) and compares that input with the preset time input from the thumbwheels (TS1-TS4, IC20-IC23). When the two inputs become equal, the comparator outputs a time out signal to the time out transient suppressor section.

### Time Out Transient Suppressor

This section (IC24(1), IC24(2)), shown in Fig. 7, is merely an added precaution to deal with the possibility of erroneous transients in

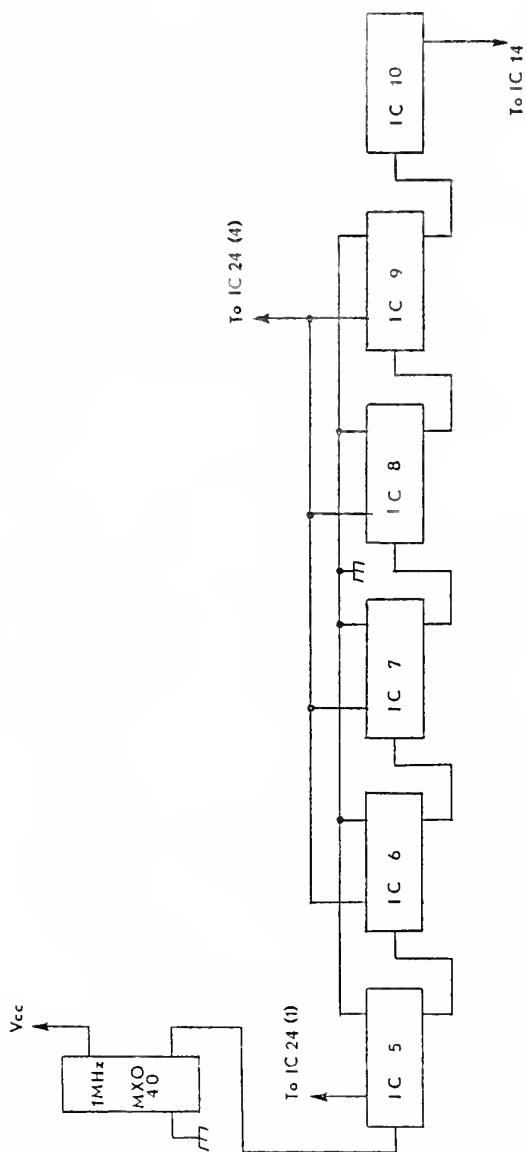


Figure 3. Oscillator and frequency divider

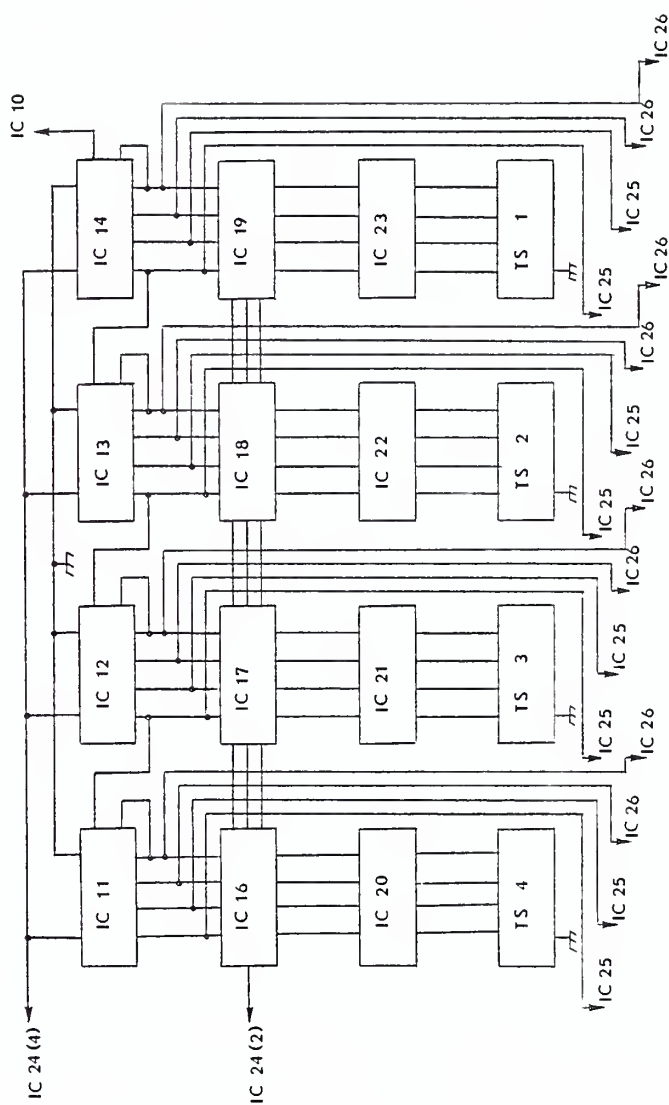


Figure 4. Timing decades and comparator

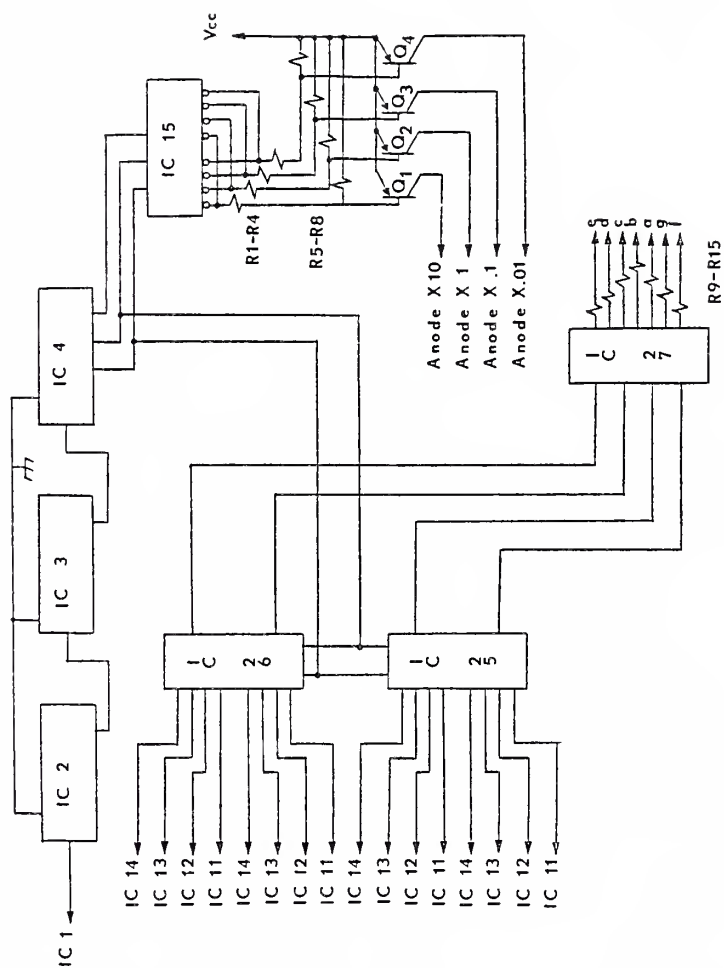
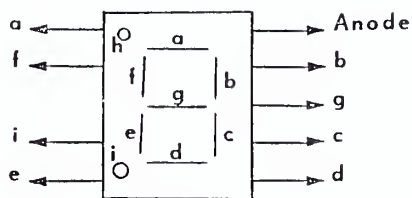
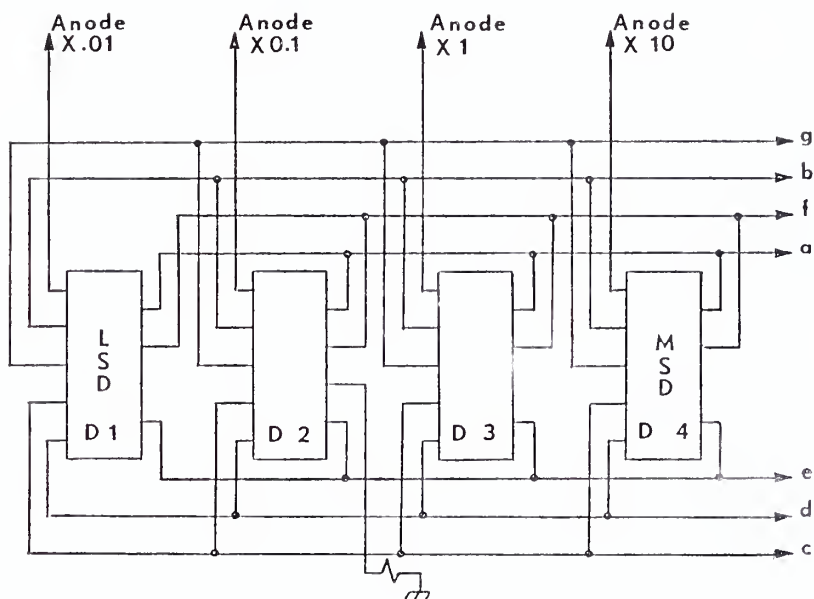


Figure 5. Display drivers



Typical  
D1-D4

Display

Figure 6. LED displays

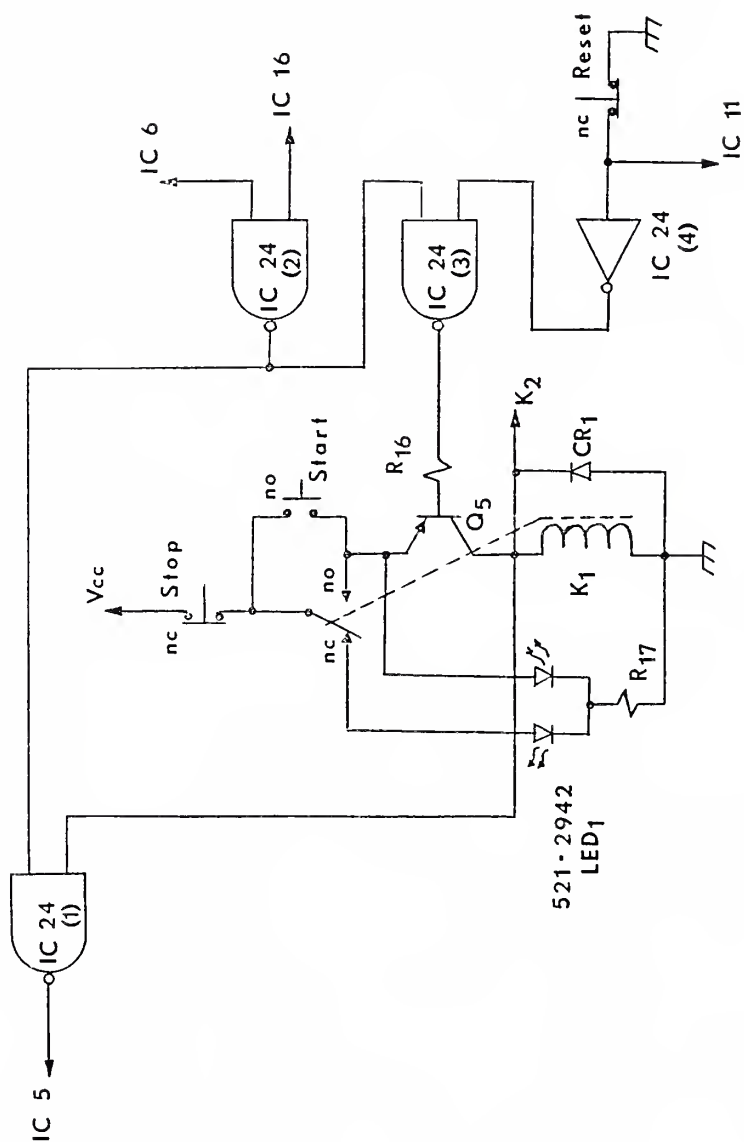


Figure 7. Lockout and time out transient suppressor



the timeout signal line. These transients might occur when the timing decades increment. It should be noted here, however, that the timing decades are "ripple counters" and, as such, should pass through binary values less than the previous values as the counter ripples to the next value. Consider, for example, a four bit counter whose present binary value is 0111. Upon receipt of the next clock pulse, the counter might go to the next value as follows:

0111    0110    0100    0000    1000.

That is, the counter would ripple through decimal values of 6, 4, and 0 before the new value 8 is reached (the reader should bear in mind that the ripple occurs in about 70 nsec). Under normal conditions, this action would serve to suppress any transients. It was determined, however, that because the transient suppressor would not introduce a severe hardware penalty (in fact, the transient suppressor in the final design would not add to the component count), it should be included. The circuit, by its design nature, necessarily adds 50 nsec delay to the time out signal as seen by the lockout and relay driver section.

### Lockout and Relay Driver

This section (IC24(3), K1, Q5) provides the drive to the power relay during timed operations and insures relay turn off and lockout upon receipt of a time out signal. The lockout portion of the circuit dictates that the power relay will always be inactive when power is first applied to the system. Further, when the circuit is in the locked out state, the first stage of the frequency divider circuit is disabled, thereby holding the timing decades section in its present state. Therefore, when the preset time is reached, the power relay is disabled and the elapsed time display halts.

### Power Relay

The power relay (K2), shown in Fig. 8, is a hybrid design, in that the isolation section is a reed relay and the power section is composed of solid state circuitry. At 60 Hz, the relay exhibits a maximum operate time of 2 msec and a maximum release time of 9 msec. The output section of the relay is rated for 120 VAC and 10 A maximum.

### Preset Time Thumbwheels

The thumbwheels (TS1-TS4) provide an interface between the operator and the timer. A preset time is entered using the thumbwheels and the system will time out when this preset value is reached.

## RESULTS

The overall timing error of the system is comprised of several smaller errors which occur at different locations within the system. The crystal controller time base is, by specification, accurate to  $\pm 0.01\%$  at 25°C and has extremely low time and temperature frequency drift coefficients. The timing decades and comparator sections collectively add a

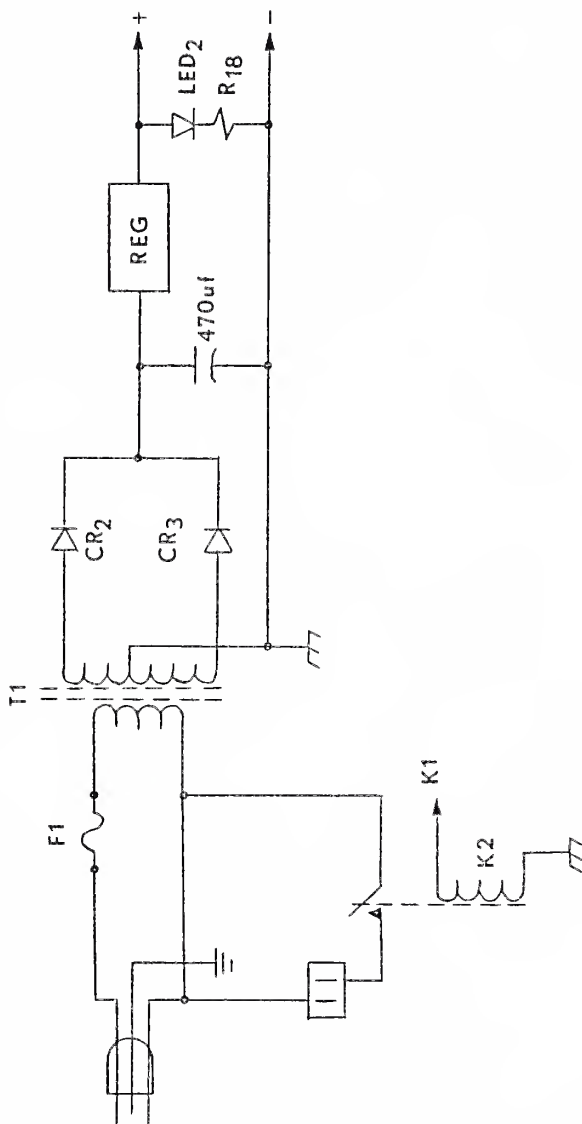


Figure 8. Power supply and power relay

1  $\mu$ sec maximum delay. This delay, however, is coexistent with a 50  $\mu$ sec delay introduced by the time out transient suppressor and, as a result, the larger of the two errors dominates. The lockout and relay driver section adds another 10  $\mu$ sec delay in addition to that introduced previously. Finally, the power relay introduces an additional 9 msec maximum delay. If all delays occur in worst case quantities, the total delay is 9.06 msec, which is just slightly greater than 1.5% of the least significant time increment. This worst case time delay is absolute and will not increase as preset time increases. Including the 0.01% maximum error which might be introduced by the time base, the total worst case timing error becomes

$$E_t = \frac{0.0151 + P(0.01)}{P}, \quad (3)$$

where P is the preset time as set on the thumbwheels and  $E_t$  is the error expressed in percent.

For example, if the preset time selected is 0.1 min., then the maximum error would be

$$E_t = \frac{0.0151 + (0.1)(0.01)}{0.1} = 0.161\%. \quad (4)$$

There will be an additional timing delay introduced by the mechanical system, which is comprised of the radiation door and the radiation door position solenoid. To obtain an approximation of the magnitude of this delay, it would be beneficial to assume a frictionless system (machined and polished door and guide), a 3.81 cm radiation door travel, a radiation door-solenoid arm weight of 2.22 N and a constant solenoid force of 11.12 N.

Upon opening, the acceleration of the door due to the solenoid force is given by

$$A_d = \frac{F_s}{M_d} = \frac{9.8 (11.12)}{2.22} = 49.09 \text{ m/sec}^2. \quad (5)$$

The time required for the door to open 3.81 cm may be written as

$$t_o = \sqrt{\frac{2 (0.0381)}{(49.09)}} \approx 39 \text{ msec}. \quad (6)$$

When the door closes, the time required is determined by evaluating

$$t_c = \sqrt{\frac{2 (0.0381)}{9.8}} \approx 88 \text{ msec}. \quad (7)$$

Because both door timing errors are delays, the two times will add algebraically so that the net error is 49 msec. Due to the foregoing assumptions, this figure is only approximate. The assumption that the solenoid force is constant will partially offset the frictionless assumption. In other words, the solenoid force starts at 11.12 N at the full stroke

(door closed) and increases proportionally to the square of the travel. This would actually result in shorter opening times. Of course, when the door closes there is no soleroid force, only frictional force, which means that the door closes slightly slower than calculated. In summary, for radiation exposure times greater than 0.1 min the entire system introduces an error less than 1%. This error is compatible for any present usages in beta dosimetry or therapy.

The irradiator has been proven to deliver precisely reproducible dose rates of beta radiation for TLD's and film badges of all standard configurations. Although this particular apparatus must be oriented so that the radiation door is operated in a vertical plane (the reader should remember that the radiation door free falls to the closed position), the addition of a push-pull solenoid arrangement would allow the device to be used in any plane. The timing error would then be further reduced since the time required for the door to close is the largest error. The system allows the operator to be absent for the duration of long irradiations. Operator error in reading the times will also be reduced due to the presence of easily readable LED's and thumbwheels.

*Acknowledgements.* The authors would like to thank The University of Michigan Physics Machine Shop for precision machine work.

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DETERMINATION OF THE ECOLOGICAL THRESHOLD AND THERMAL  
CONSTANT OF THE LARVAL STAGE OF *Heliothis zea*<sup>1,2</sup>

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*Abstract.* The ecological threshold of development and the thermal constant for the larval stage of *Heliothis zea* (Boddie) were determined by exposing larvae from a laboratory colony to a constant temperature from the first larval instar until pupation occurred. Each representative sample of the larvae was exposed to one of the following constant temperature levels: 64, 70, 75, 80, 86 and 91 degrees Fahrenheit. The ecological temperature threshold of development for the larval stage was found to be 56°F, and the thermal constant for this stage was determined to be 361 day-degrees.

#### INTRODUCTION

The use of thermal summation to express the relationship between temperature and the rate of biological processes is not new. It is reported that Reaumer as early as 1735 suggested that the sum of average daily temperatures during the growing season influences the time at which fruit ripens (Allee et al. 1950). This concept has been more extensively utilized in the 20th century as biologists sought to find an index to represent the heat energy required for the completion of the life cycle of an organism or the stages thereof. The concept is based upon the law of constant heat summation of thermochemistry which states that the quantity of heat involved in a chemical process is the same whether it takes place in one or several increments (Getman and Daniels 1931). The application of this principle to biological reactions is contingent upon establishing the thermal threshold of development or ecological zero for the function under consideration. This threshold is ascertained experimentally by determining the temperature level which must be exceeded for the successful completion of a given stage or process. Extensive experience of phenologists has shown that the rate of

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accumulation of a daily thermal excess above this base level will closely coincide with the rate of completion of a given biological process. The cumulative thermal excess is expressed in units of day-degrees, this unit being one degree of mean temperature above the ecological zero level for one day. The number of day-degrees required to complete a given process is referred to as the thermal constant for that process or stage. Each of the various developmental stages of a locally adapted population is likely to have its own unique ecological zero and thermal constant.

With knowledge of the ecological zero and thermal constant, it is possible to predict with reasonable accuracy both the inception and duration of the destructive stage and thus prepare to initiate appropriate control measures. This study involves a determination of these two critical points for the destructive stage of an important cotton pest, *Heliothis zea* (Boddie).

The various aspects of the life cycle of the cotton bollworm *Heliothis zea* (also known as the corn/ear worm) have been known for some time (Quaintance and Brues 1905, Ditman and Cory 1931). However, a search of the literature discloses no attempt prior to 1963 by these or other investigators to relate thermal summation to the growth characteristics of this species. At that time Luckmann (1963) ascertained the incubation period for the cotton bollworm eggs at several temperatures and reported a temperature threshold of 54°F for that life stage. An accumulation of 72 day-degrees above this base temperature was required for egg hatching. Mangat and Apple (1966) applied this principle along with the temperature threshold of development to determine the cumulative heat energy requirement for the development of *Heliothis zea* from egg to adult. These investigators determined the ecological zero point to be 54.7°F, and the temperature constant for development (from newly oviposited eggs to 75% adult emergence) to be 690.2 day-degrees above this base temperature.

In an investigation of the life cycle of another insect pest, Matteson and Decker (1965) determined the threshold of development for the various stages of the European corn borer *Ostrinia nubilalis* to be 57.3°F for the egg stage, about 52°F for the larval stage and approximately 45.5°F for the pupal stage.

Since temperature thresholds of development for the different stages in an insect life cycle may differ among species, the aim of this investigation was to determine the temperature threshold for the larvae of a locally adapted strain of *H. zea*. After establishing the temperature threshold, calculations were made to determine the mean day-degrees above this base temperature required to complete the larval stage, the destructive and probably the most vulnerable stage of the life cycle.

#### METHODS AND MATERIALS

The study was conducted in the biology laboratory of Alabama A. & M. University during 1972. The cotton bollworm moths employed to initiate the laboratory culture were derived from a natural population occurring

near Huntsville, Alabama. Moths were attracted from the field with a fluorescent blacklight and deflected into a walk-in cage. These field collected moths were confined in an oviposition cage containing 10 males and 10 females. The oviposition cage was identical to that described for the black cutworm by Mangat (1970). The cage was put in a constant temperature growth chamber set at 75°F ( $\pm 1^\circ$ ) with a relative humidity of 85-90 percent. Adults were fed a 10% honey solution.

Strips of cheesecloth were placed inside the cage to serve as a surface for oviposition. Eggs of comparable age were obtained by exposing these strips for only 2 hours. The eggs were disinfected by soaking for five minutes in a freshly prepared 0.15% sodium hypochlorite solution and washed with sterile distilled water. The eggs were transferred with a sterilized brush to a vial (95  $\times$  25 mm) of rearing medium (Mangat 1970) with one egg per vial. These vials were kept in an incubator maintained at 75°F and were checked frequently to determine exact exposure time. Vials containing newly hatched larva were exposed to one of six test temperature levels. These test levels were 64, 70, 75, 80, 86, and 91 degrees Fahrenheit. Prior to the experiment, the thermostat of each controlled-temperature cabinet was set at the appropriate level and time was allowed for the temperature to equilibrate. No attempts were made to maintain constant relative humidity in the cabinets. At least 1 daily reading of the temperature of each cabinet was recorded throughout the period of the experiment. The records showed no variation beyond  $\pm 1^\circ$ F. The vials were checked twice daily for the appearance of pupae.

## RESULTS AND DISCUSSION

Data on the time required for larval development and percent of development per day at six constant temperatures are presented in Table 1. The mean length of the larval stage ranged from 9.6 ( $\pm 0.8$ ) days at 91°F to 48.2 ( $\pm 2.9$ ) days at 64°F. Figure 1 shows the percent development of larvae per day ranging from 2.7 to 10.4 and the linear regression line fitted to the data. The point at which the regression line intersects the X axis, 56°F, was used as the temperature threshold of

Table 1. Time (days) required and mean percent development per day by cotton bollworm larvae reared at constant temperature

Temp (°F)	Number Reared	Mean Duration (Days, $\bar{X} \pm SD$ )	Range	Mean Percent Development per Day
64	25	48.2 $\pm$ 2.9	43-53	2.7
70	21	26.6 $\pm$ 1.9	24-29	3.8
75	27	20.0 $\pm$ 1.5	18-22	5.0
80	26	14.2 $\pm$ 0.8	13-16	7.0
86	22	11.8 $\pm$ 0.9	10-13	8.5
91	24	9.6 $\pm$ 0.8	8-11	10.4



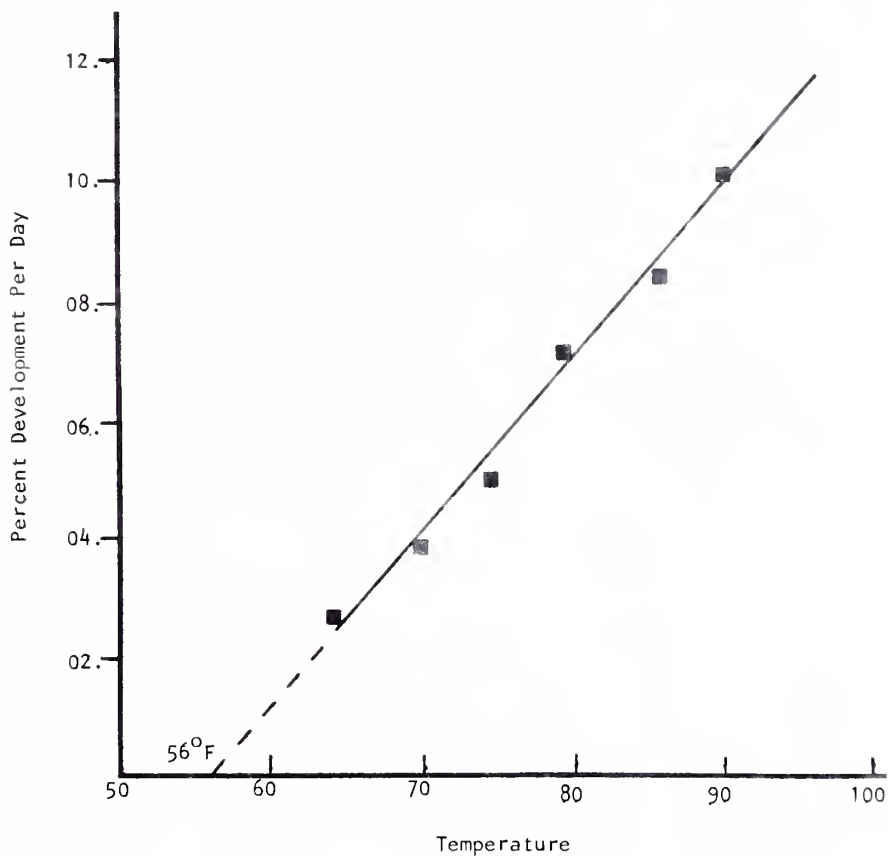


Figure 1. Regression of percent development of cotton bollworm larvae per day on temperatures (°F)

development or a base temperature to calculate the day-degrees for each experimental temperature. The mean day-degrees accumulated above base 56°F for each temperature is presented in Table 2. The day-degree accumulations for the test larvae ranged from 336 to 385 among the experimental groups and the overall average time required for larval development was 361 day-degrees above 56°F.

Table 2. Mean day-degrees required to complete larval development above 56°F at each of 6 constant temperatures

Temp (°F)	Mean Day-Degrees
64	385
70	372
75	380
80	340
86	354
91	336
Overall Mean	361

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VERTEBRATES OF INTEREST FROM HORSESHOE BEND  
NATIONAL MILITARY PARK<sup>1</sup>

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From mid-June to mid-September, 1974, an inventory was made of the vertebrate fauna and the available habitats in Horseshoe Bend National Military Park. The primary intent of the study was to provide park personnel with information needed for future park management. The majority of the animals encountered were vertebrates common in the Piedmont region or throughout Alabama (Smith-Vaniz, 1968; Mount, 1975; Imhof, 1977; Hall and Kelson, 1959). However, certain species recorded in the study represented range extensions or, for various other reasons, were of special interest. Only these species are discussed in this paper.

The 2,040-acre park is located approximately 12.0 miles north of Dadeville in Tallapoosa County, Alabama. It is situated above the Fall Line on the Piedmont Plateau (Fenneman, 1938) and is bisected by the Tallapoosa River. Much of the park is maintained for tourist and historical reasons and consists of regularly mowed fields or even-aged pine forests. However, most of the park, particularly that portion south of the Tallapoosa River, consists of a variety of habitats which supports diverse vertebrate life (see Fig. 1).

Waterfalls along the Fall Line act as natural barriers, restricting the distribution of fishes between the Coastal Plain and upland areas of the Piedmont Plateau. All fishes collected in this study were known to occur in the Tallapoosa River, but some were thought to have been strictly Coastal Plain forms. For instance, the white crappie, *Pomoxis annularis*, was considered to be a Coastal Plain species with isolated populations above the Fall Line (Williams, 1965). This species has become established in Lake Martin about 10 miles downstream from the park

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# VEGETATIONAL MAP OF HORSESHOE BEND NATIONAL MILITARY PARK

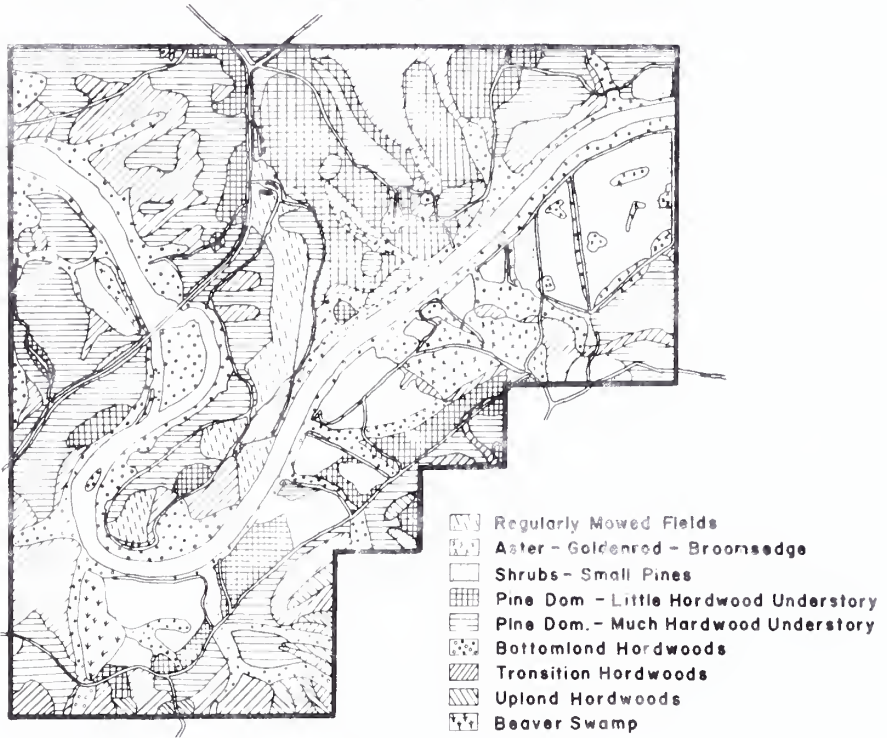


Fig. 1. Vegetational map illustrating the available habitats for vertebrate species and the location of these habitats in the park in relation to the Tallapoosa River. The numerous plant communities support a wide variety of vertebrates.

which may account for its presence in the Tallapoosa River within the park.

Another species collected, the pretty shiner, *Notropis bellus*, was considered rare above the Fall Line by Smith-Vaniz (1968). Two other species collected, the golden shiner, *Notemigonus chryssoleucus*, and the rough shiner, *Notropis baileyi*, were considered by Williams (1965) to be uncommon above the Fall Line.

Williams (1965) found the mosquitofish, *Gambusia affinis*, at only one station above the Fall Line in the Tallapoosa River system, and speculated that this species was introduced into the Piedmont, because

## Vertebrates of Horseshoe Bend

was collected in a stream flowing from a stocked pond. We found *G. affinis* to be well established in a beaver swamp near the southern boundary of the park (Fig. 1).

The green treefrog, *Hyla cinerea*, is absent from most of the upland areas of Alabama. A specimen collected in the beaver swamp represents the northernmost known locality for this species on the Piedmont Plateau (Mount, 1975).

Prior to our study, the southern distribution of the midwest worm snake, *Carphophis amoenus helenae*, was thought to be restricted by the Tallapoosa River. A specimen collected in the transition hardwood forests near the southwestern corner of the park (see Fig. 1) represents the only known record of this species south of the Tallapoosa River on the Piedmont Plateau (Mount, 1975).

A Cooper's hawk, *Accipiter cooperi*, was sighted in the transition hardwood forest near the southwestern corner of the park in mid-August. Resident populations of this species are now thought to be rare in Alabama (Keeler, 1962), although they were once common throughout the state.

Small mammals were collected with snap traps and pitfall traps. On the basis of 12 trapped specimens, the survey revealed the southeastern shrew, *Sorex longirostris*, to be one of the most abundant small mammals in the park. Until recently this species was considered rare in Alabama (Dusi, 1962), but it appears now that this may have been due to ineffective sampling methods. As French (1975) demonstrated, the use of pitfall traps is a highly effective technique for collecting shrews.

The woodchuck, *Marmota monax*, is a wide-ranging North American species that is abundant throughout much of its range. The Piedmont Plateau represents the eastern periphery of its range in Alabama (Hall and Kelson, 1959), and the woodchuck is generally uncommon in this region. We found, however, that this species is established in the park on both sides of the river.

### SUMMARY AND CONCLUSIONS

An inventory of the biota of any given area very rarely yields all possible forms that may exist, especially, when the study is conducted in only one season of the year. We feel, however, that the area within the present boundaries of Horseshoe Bend National Military Park was as carefully studied as any other area of comparable size in Alabama during a short study period. Although most of the animals encountered were common forms, we believe that these records of vertebrate species are significant to our understanding of their distributions:

#### Fishes

*Pomoxis annularis*, white crappie  
*Notropis bellus*, pretty shiner  
*Notropis baileyi*, rough shiner  
*Notemigonus chryssoleucus*, golden shiner  
*Gambusia affinis*, mosquitofish

Amphibians

*Hyla cinerea*, green treefrog

Reptiles

*Carphophis amoenus helenae*, midwest worm snake

Birds

*Accipiter cooperi*, Cooper's hawk

Mammals

*Sorex longirostris*, southeastern shrew

*Marmota monax*, woodchuck

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THE ACTIVE CENTER OF INVERTASE FROM  
*CANDIDA UTILIS*: A KINETIC STUDY<sup>1</sup>

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**Abstract.** The ionizing functional groups of amino acids at the active center of *Candida utilis* invertase were determined by kinetic methods using sucrose and raffinose as substrates. Dixon plots of  $-\log$  Michaelis constant against pH at 30° for sucrose hydrolysis showed ionizing groups in the free enzyme with apparent  $pK_a$  4.4, and in the enzyme-substrate complex with  $pK_a$  3.8. Similar plots for raffinose at 25° gave  $pK_a$  values of 4.3 and 3.5 for groups in the free enzyme and enzyme-substrate complex, respectively. There was little evidence for a second ionizing group with  $pK_a$  6-7 shown by other authors for *Saccharomyces cerevisiae* invertase. Redetermination at 50° of the  $pK_a$  in the free enzyme seen in raffinose hydrolysis allowed calculation of the heat of ionization, which was found to be -810 cal/mole. This group was identified as carboxyl. The heat of ionization for both groups in the free enzyme and enzyme-substrate complex seen in sucrose hydrolysis was 8900 cal/mole. It is suggested that this relatively high value could be due to a carboxyl group whose ionization was altered by local protein effects at the active center, possibly related to strong binding of sucrose to the enzyme. Functional groups thought to participate at the active center of invertases from different sources were discussed. These studies also showed that sucrose hydrolysis exhibited substrate inhibition at pH's above 4.5 and, with both sucrose and raffinose as substrates, there was some apparent cooperative substrate binding.

#### INTRODUCTION

Both direct chemical modification and indirect kinetic methods have been used to determine chemical functional groups at the active center of invertases ( $\beta$ -D-fructofuranosidase fructohydrolyase, EC 3.2.1.26) from a number of sources. A knowledge of such groups is important for understanding their role in catalysis and in control of enzyme activity. Thus, inhibition of invertase from *Saccharomyces cerevisiae* by mercury and other heavy metal ions has suggested the presence of cysteinyl sulfhydryl and histidyl imidazole at the active center (Myrback, 1960; Kidby,

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1974). The latter group has also been implicated by inhibition studies using diazonium tetrazole (Leskovac et al., 1975) and by extensive kinetic studies (Myrback, 1960; Shall and Waheed, 1969; Fedorov and Malinovskii, 1973). Iodine inhibition of this enzyme has suggested the presence of the thiomethyl side chain of methionine (Waheed and Shall, 1971) while inhibition by N-bromosuccinimide has shown a requirement for tryptophanyl indole at the active center (Leskovac et al., 1975). The carboxyl group of aspartic acid has been definitely shown to be at the active center of rabbit small intestine invertase-isomaltase, which apparently possesses two active centers (Quaroni and Semenza, 1976; Brawn et al., 1977). This group, from either aspartic or glutamic acid, is also probably necessary for the catalytic function of *Saccharomyces cerevisiae* invertase (Myrback, 1960; Shall and Waheed, 1969; Waheed and Shall, 1971).

One would expect that invertases from a wide variety of sources would possess the same or very similar functional groups which bind the substrate and catalyze the chemical reaction, although different groups would be expected to participate in allosteric or other control of enzyme activity (Dixon and Webb, 1964). However, the literature has shown significant inconsistency with respect to both experimental results pertaining to active-site functional groups from the same enzyme (Myrback, 1960; Leskovac et al., 1975; Dixon and Webb, 1964) and from different enzymes (Bigger and Braymer, 1975), so that it becomes important to find which groups directly function in substrate binding and catalysis and to ascertain the degree to which results obtained from one invertase may be applied to another. Accordingly, we have examined the kinetics of invertase from *Candida utilis*, using sucrose and raffinose as substrates, as a function of pH and have found the apparent  $pK_a$ 's of groups ionizing in the free enzyme and enzyme-substrate complex. These were determined at several temperatures and the results plotted according to the method of Dixon (Dixon, 1953; Dixon and Webb, 1964) which allowed calculation of the heats of ionization. From both the  $pK_a$ 's and heats of ionization the groups were identified. This study also better characterizes invertase from *Candida utilis* and shows that there is considerable substrate inhibition for sucrose hydrolysis at pH's above 4.5, while for both sucrose and raffinose as substrates there is evidence of cooperative substrate binding.

## MATERIALS AND METHODS

Sucrose, D-glucose, D-fructose, 3,5-dinitrosalicylic acid, bovine serum albumin, Sephadex G-200, and highly purified invertase from *Candida utilis* (grade X) were purchased from Sigma Chemical Company. Raffinose was purchased from P-L Biochemicals Company. All other chemicals were reagent grade obtained from commercial sources. Citrate-phosphate buffers at the several pH's were prepared according to Dawson et al. (1969). Enzyme was further purified by column chromatography on Sephadex G-200 using 0.05 M citrate-phosphate, pH 4.8, as elution buffer. Enzyme activity was assayed by the method of Clark (1964). At each pH and temperature the assay contained 0.05 M citrate-phosphate, enzyme, and either sucrose or raffinose in a final volume of 3.0 ml. Molar concentrations of sucrose were 0.0033, 0.010, 0.020, 0.033, 0.050, 0.066, 0.0833, or 0.100. Molar concentrations of raffinose were 0.0166, 0.0266, 0.033,

0.0433, 0.050, or as indicated in the Results section. Assay time was five minutes. Assay pH was routinely checked using a Corning Model 12 pH meter, corrected for temperature. Temperature was maintained using a water bath circulator-heater unit equipped with a cooler (Sargent Welch Company). Absorbance in the developed assays was determined at 540 nm using either a Chem-Anal spectrophotometer (Sargent Welch Company) or a Perkin-Elmer Coleman 124 double beam spectrophotometer. One unit of enzyme activity is defined as the amount of enzyme that catalyzes the hydrolysis of one  $\mu$ mole of sucrose or raffinose per minute. Specific activity is expressed as units per milligram protein. Protein was determined by the method of Lowry et al. (1951), using bovine serum albumin as standard. Assays were linear with time and the enzyme concentration used. Michaelis constants and maximal velocities were determined by the method of Lineweaver and Burk (1934). In the studies with sucrose as substrate, points which showed substrate inhibition of the enzyme were not used in calculating the Michaelis constants or maximal velocities. At a given pH and temperature quadruplicate sets of assays used in determining the initial velocity as a function of substrate concentration gave variabilities in the resultant Michaelis constants and maximal velocities of five percent or less. With raffinose as substrate, it was found that Lineweaver-Burk plots were not linear at 0.0033, 0.0066, and 0.010 molar raffinose and these concentrations were not routinely used in determining the kinetic constants. Ionization constants for enzyme functional groups were determined by the double logarithmic method of Dixon (Dixon and Webb, 1964), with abscissa and ordinate of equal unit length. Such ionization constants are considered reliable in the range  $\pm 0.3$  pK units.

## RESULTS

Invertase from *Candida utilis* is stable in the range pH 3-6 (Figure 1A). The enzyme is unstable below pH 2.0. The optimal pH with sucrose as substrate is 5.2 at low substrate concentration (10 mM sucrose); this shifted to pH 4.9 at high substrate concentration (66 mM sucrose) and was accompanied by increased enzyme activity in the range pH 3-5 (Figure 1B, 1C). With raffinose as substrate the optimal pH was 5.4 and was unaffected by substrate concentration (Figure 2). The enzyme was unstable above pH 7.5 with either substrate. The specific activity of our preparation of *C. utilis* invertase was 159  $\mu$ moles sucrose hydrolysed per minute per milligram protein (0.066 M sucrose, pH 4.9, 30°) and 34.2  $\mu$ moles raffinose hydrolysed per minute per milligram protein (0.050 M raffinose, pH 5.3, 25°).

The effect of sucrose concentration on the initial velocity of sucrose hydrolysis at 30° is shown in Figure 3. At pH's below approximately 4 essentially Michaelis kinetics (hyperbolic) were found at sucrose concentrations above 0.020 molar. However, below this substrate concentration some sigmoidicity was found in the curves (Figure 3A, 3B), which could indicate cooperative substrate binding. At pH's greater than 4.5 increasing sucrose concentration inhibited the enzyme (Figure 3C, 3D). Increasing the pH from 3.2 to 5.7 results in approximately three-fold lowering of the Michaelis constant (Figure 3B, 3D). Substrate inhibition was not apparent with raffinose as reactant (Figure 4).

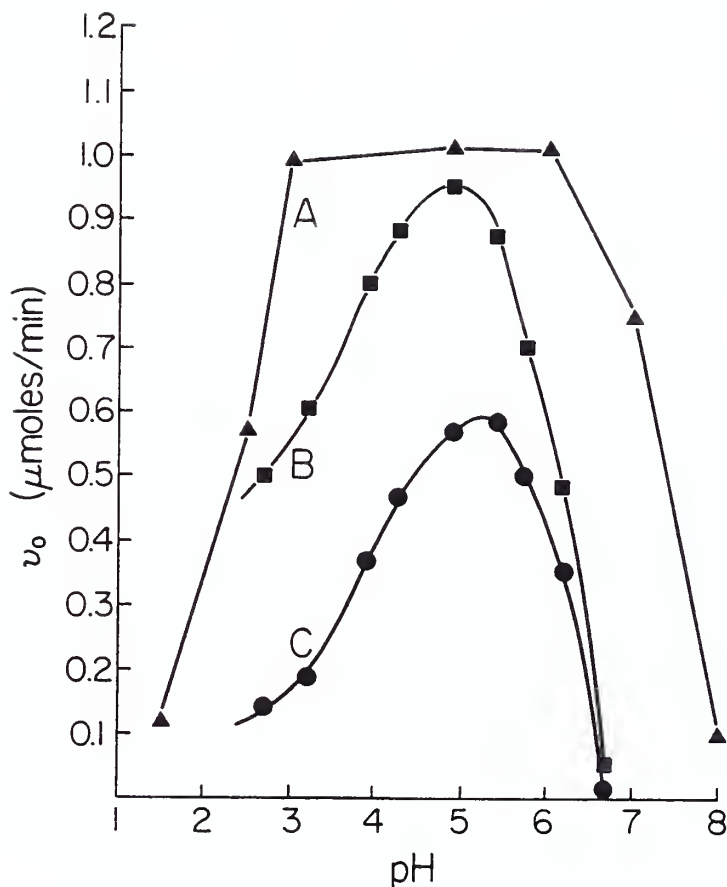


Figure 1. The effect of pH on the stability and initial velocity of sucrose hydrolysis by *Candida utilis* invertase. In examining stability (curve A), enzyme (61  $\mu\text{g}$ ) was incubated at the indicated pH for 30 minutes, then diluted ten-fold with 0.05 M citrate-phosphate buffer, pH 4.9. A 1.0 ml portion was assayed at pH 4.9 and 30° at 83.3 mM sucrose. Curves B and C show initial velocities at 30° as a function of pH at 66 mM and 10 mM sucrose, respectively. Quantity of enzyme per assay was 6.0  $\mu\text{g}$ . Other assay conditions are given in the Methods section.

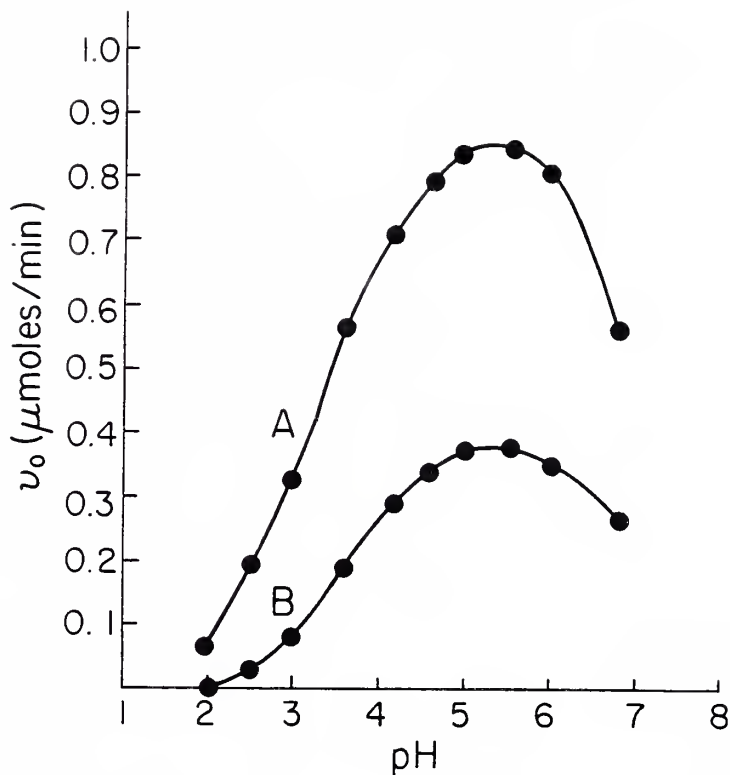


Figure 2. The effect of pH on the initial velocity of raffinose hydrolysis by *Candida utilis* invertase at 25°. In curve A, raffinose concentration was 0.050 M; in curve B, 0.0166 M. Quantity of enzyme per assay was 25  $\mu$ g.

Sigmoidicity of substrate concentration-initial velocity curves was found at low raffinose concentrations over the entire pH range of the study; again, cooperative substrate binding may be present. In accordance with early work with *Saccharomyces cerevisiae* invertase (Myrback, 1960), sucrose was found to be a better substrate than raffinose.

With sucrose as substrate, maximal velocity rises to a maximum at pH 4.9, followed by a steep decline on the alkaline side of the maximum (Figure 5A). The maximal velocity for raffinose hydrolysis is found at pH 4.0. However, the enzyme retains considerable activity at pH's above 4 with this substrate (Figure 6A). Apparent affinity of the enzyme for sucrose and raffinose, as measured by the Michaelis constant,  $K_M$ , increases in the range pH 2-5, above which it attains a limiting value for

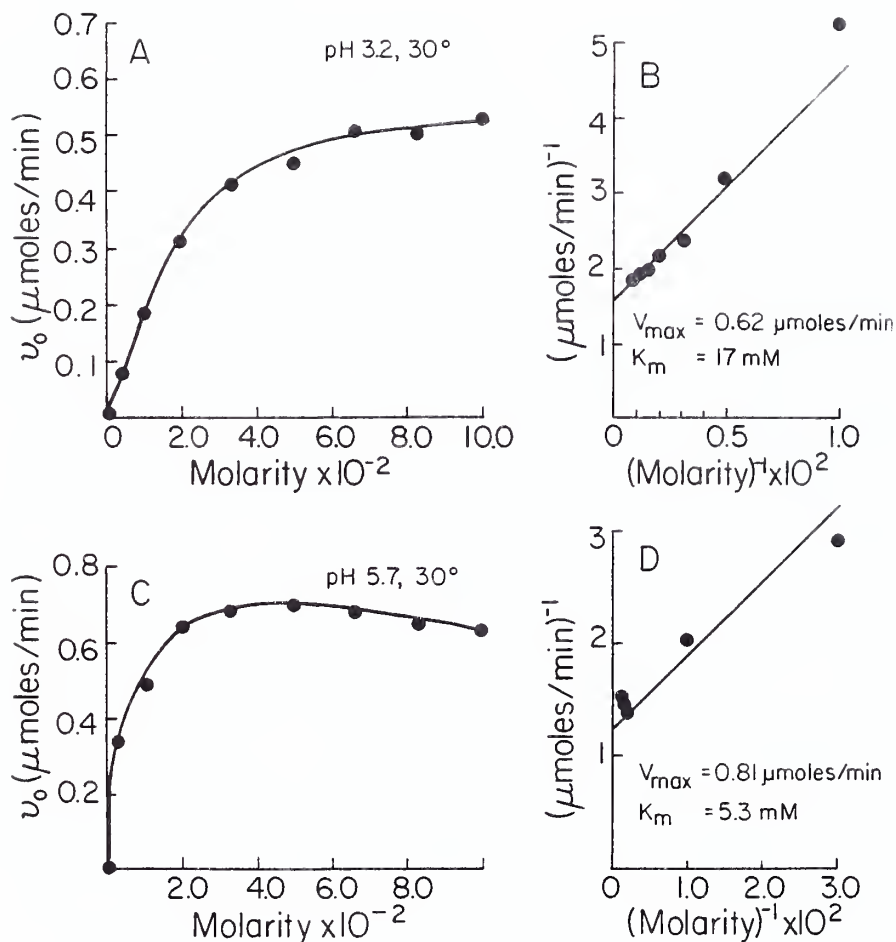


Figure 3. The effect of sucrose concentration and pH on the initial reaction velocity at 30°C. Assay enzyme concentration was 2.0  $\mu\text{g/ml}$ . Specific activity at pH 3.2 was 103 units/mg; at pH 5.7, 135 units/mg. In graphs B and D the data of graphs A and C, respectively, are plotted by the method of Lineweaver and Burk. Substrate inhibition is evident at the higher pH.

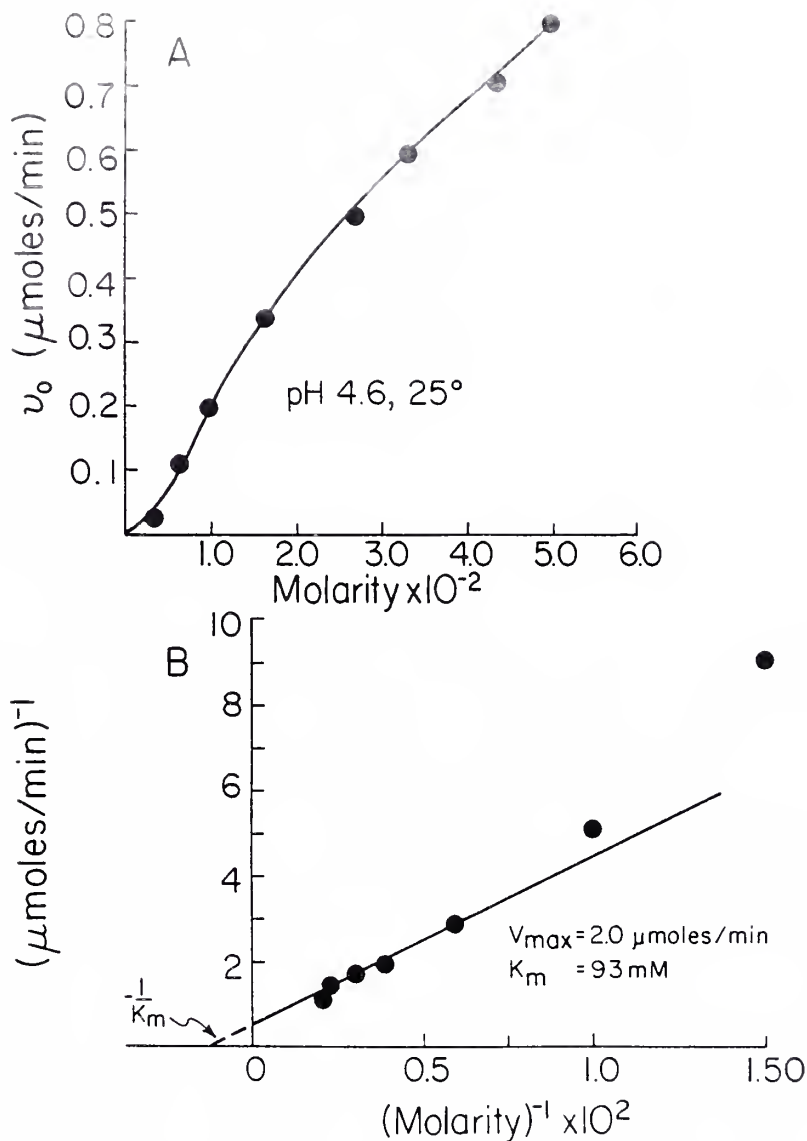


Figure 4. The effect of raffinose concentration on the initial velocity of raffinose hydrolysis at pH 4.6 and  $25^\circ$ . The data of part A are regraphed in part B according to the method of Lineweaver and Burk. Enzyme concentration was  $8.3 \mu\text{g}/\text{ml}$ . Specific activity was  $80 \text{ units}/\text{mg}$ . At lower raffinose concentrations (0.0033, 0.0066, and 0.010 molar), Michaelis-Menton kinetics were not followed.

both substrates (Figures 5B and 6B).  $K_m$  Sucrose also appears to reach a limiting value at pH's below 2.5.  $K_m$  Raffinose is approximately ten-fold higher than  $K_m$  sucrose over most of the pH range studied.

In order to identify ionizing groups in the free enzyme and enzyme-substrate complex, the data on the effect of pH on  $K_m$  sucrose and  $K_m$  raffinose were regraphed according to the method proposed by Dixon and extended by Laidler (Dixon, 1953; Dixon and Webb, 1964; Laidler, 1958). The graph for  $K_m$  sucrose at 30° (Figure 7A, 30°) shows ionizing groups in the free enzyme (curve concave downward) and enzyme-substrate complex (curve concave upward) with apparent  $pK_a$  values of 4.4 and 3.8, respectively. At 25°,  $pK_m$  (-log  $K_m$ ) raffinose as a function of pH follows a pattern similar to that of  $pK_m$  sucrose, with  $pK_a$ 's of 4.3 and 3.5 for free enzyme and enzyme-substrate complex, respectively (Figure 7B, 25°). However, the  $pK_m$  values at pH's below 4.5 approach limiting values very gradually, if at all, so that assignment of an apparent  $pK_a$  3.5 for the enzyme-substrate complex must be somewhat tentative. Similar trends for  $pK_m$  sucrose and  $pK_m$  raffinose were found at 50° (Figure 7A, 7B).

At maximal velocity all of the enzyme is in the form of enzyme-substrate complex; graphs of log maximal velocity against pH give apparent  $pK_a$  values for ionizing groups in the enzyme-substrate complex only (Laidler, 1958; Dixon and Webb, 1964). We have found that such graphs for *C. utilis* invertase catalysis of sucrose hydrolysis show an ionizing group with  $pK_a$  3.5, which confirms the finding of such a group in the enzyme-substrate complex in the graphs of  $pK_m$  as a function of pH.

Apparent heats of ionization,  $\Delta H_i$ , of groups in the free enzyme and enzyme-substrate complex may be obtained by determining the effect of pH on the Michaelis constant at several temperatures (Dixon and Webb, 1964). Logarithmic plots of data obtained on the effect of  $K_m$  sucrose for *C. utilis* invertase at 15°, 30°, and 50° are presented in Figure 7A. The effect of increasing temperature is to lower the  $pK_a$  of both groups in the free enzyme and enzyme-substrate complex by 0.022  $pK_a$  units per degree. This temperature coefficient corresponds to a heat of ionization of 8900 cal/mole at 25° (Figure 8). Temperature has little effect on the  $pK_a$  for free enzyme seen in raffinose hydrolysis, which had a heat of ionization of -810 cal/mole at 25° (Figure 7B and 8).

## DISCUSSION

Kinetic studies of enzyme catalysis as a function of pH and temperature, in the range of inherent enzyme stability, indicate the presence of only ionizing functional groups directly involved in substrate binding and catalysis; all other groups remain 'silent' by this method, which is thus highly selective (Laidler, 1958; Dixon and Webb, 1964; Bray and White, 1966). Such excluded groups could be either those removed from the active center or those ionizing outside the pH range of the study. With this in mind it is apparent that a side-chain carboxyl group of aspartic or glutamic acid participates in both the free enzyme and enzyme-substrate complex of *Candida utilis* invertase. This is shown by the low  $pK_a$  values for sucrose and raffinose hydrolysis (Figure 7A, 7B)



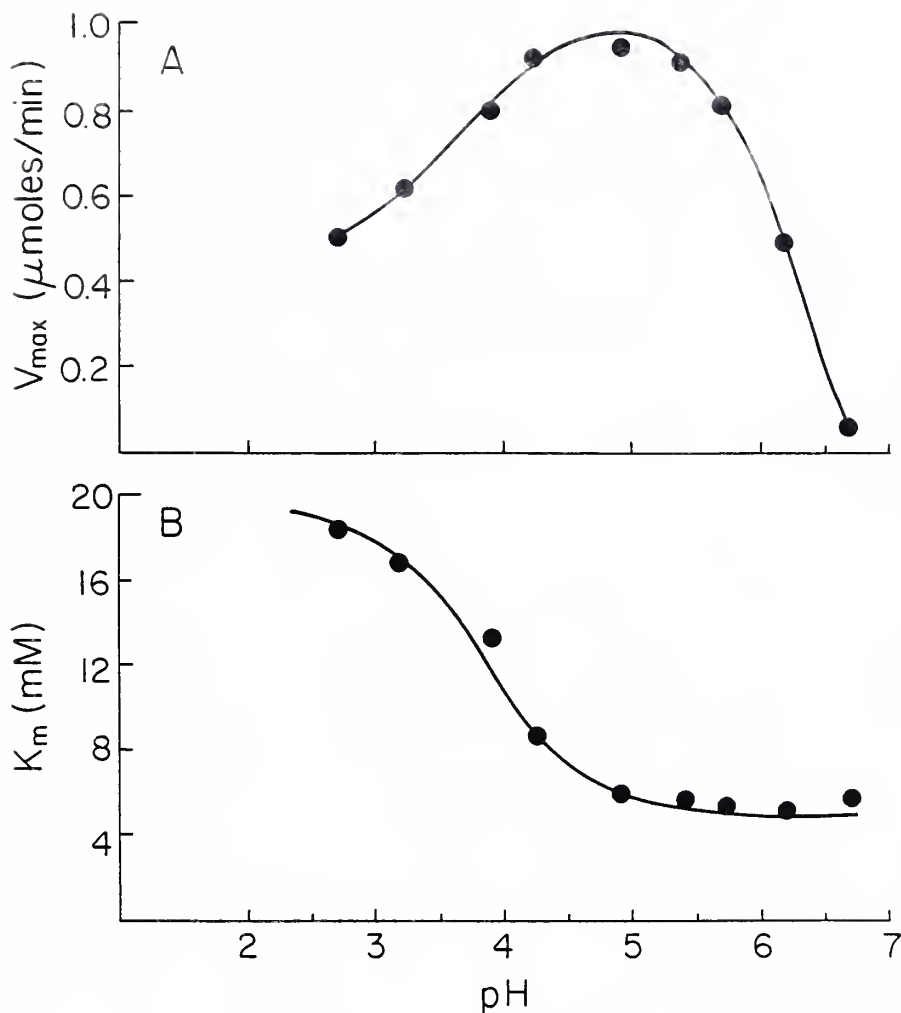


Figure 5. The effect of pH on the maximal velocity ( $V_{\max}$ ) and Michaelis constant ( $K_m$ ) for sucrose hydrolysis at 30°.  $V_{\max}$  and  $K_m$  were determined from Lineweaver-Burk plots at each pH. Enzyme concentration was 2.0  $\mu\text{g/ml}$ .

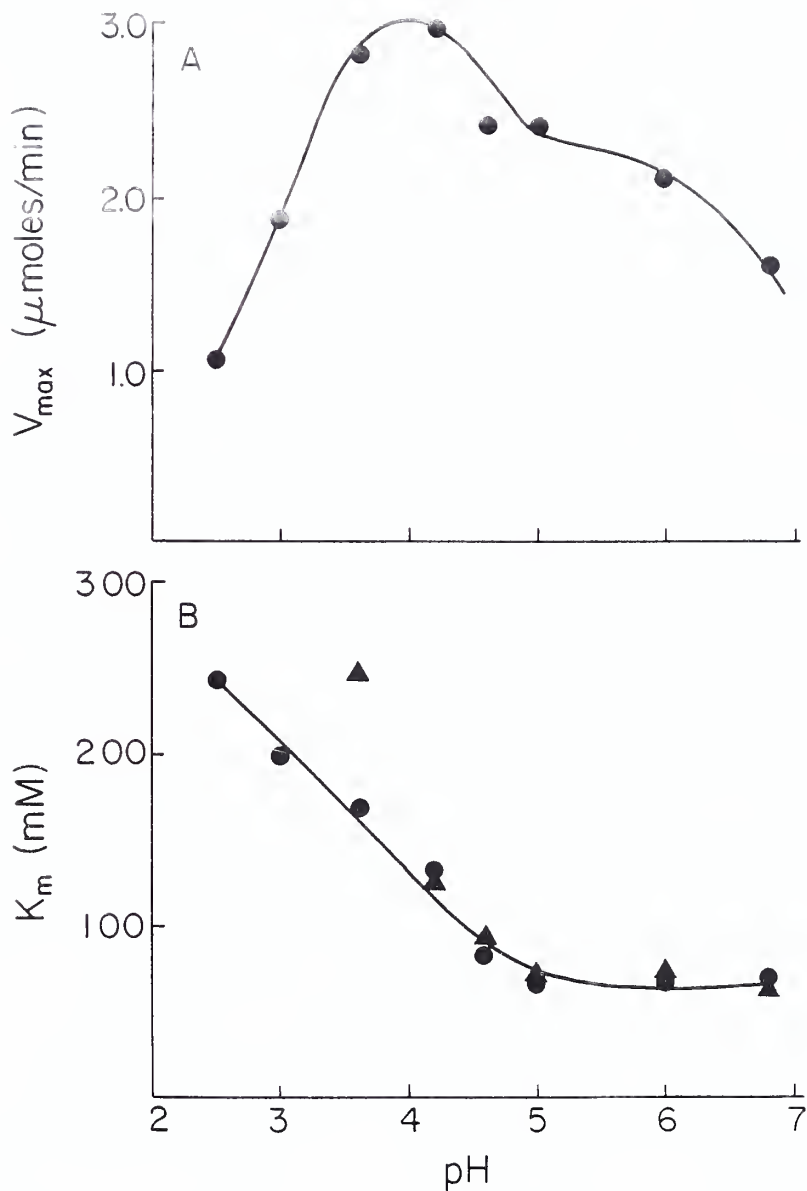


Figure 6. (A) The effect of pH on the maximal velocity ( $V_{\max}$ ) of raffinose hydrolysis at 50°. (B) The effect of pH on the Michaelis constant for raffinose. Solid triangles are data taken at 25°; solid circles, at 50°. Except for the data at pH 3.6, the temperature has little effect on  $K_m$ .

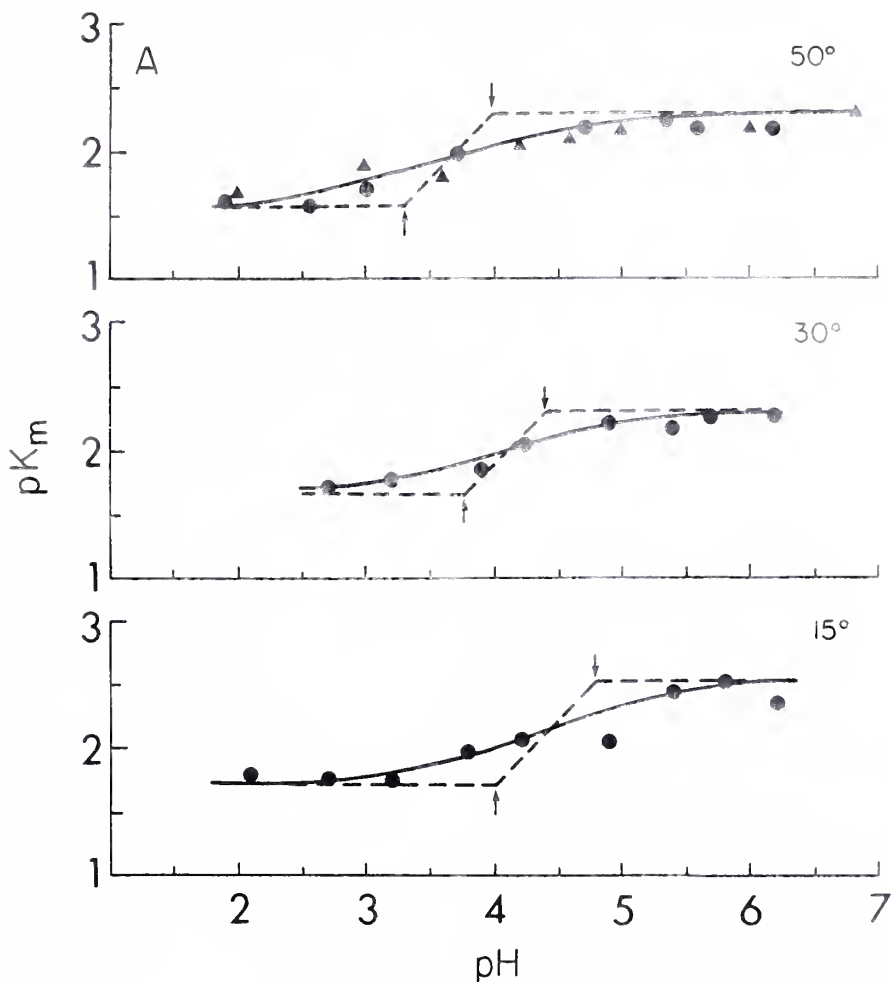


Figure 7A. The effect of pH and temperature on the Michaelis constant for sucrose hydrolysis. Data for  $K_m$  are graphed by the method of Dixon and Webb, where  $pK_m = -\log K_m$ . Data indicated by solid triangles at 50° were obtained in a second series of experiments. The arrow at lower pH at each temperature indicates a  $pK_a$  of an ionizing functional group in the enzyme-substrate complex; the arrow at the higher pH indicates the  $pK_a$  of a group in or near the free enzyme active center. The effect of increasing temperature is seen to decrease the  $pK_a$  of both groups.

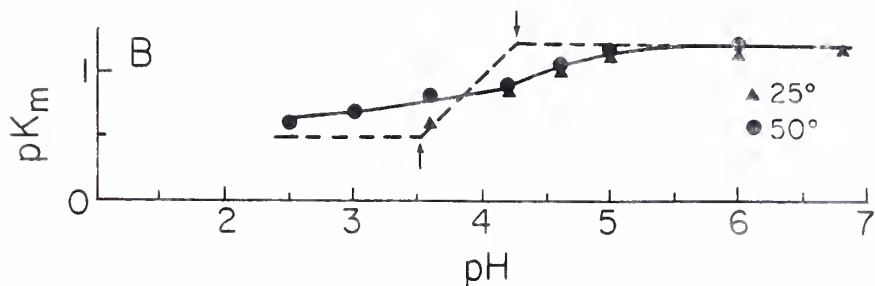


Figure 7B. The effect of pH and temperature on the Michaelis constant for raffinose hydrolysis. Data at 25° (solid triangles) and 50° (solid circles) are plotted as in Figure 7A. Increase in temperature has little effect on the group seen ionizing in the free enzyme with  $pK_a$  4.3. The data were insufficient to allow determination of the effect of temperature on the group ionizing in the enzyme-substrate complex.

and by the low heat of ionization obtained for the group ionizing in the free enzyme in raffinose hydrolysis (Figures 7B and 8) (Cohn and Edsall, 1943; Dixon and Webb, 1964). Further evidence that the functional group seen in free enzyme is that seen in the enzyme-substrate complex is that their heats of ionization in sucrose hydrolysis are identical (Figure 8). Binding of either substrate causes a decrease in the apparent  $pK_a$  of the active center carboxyl group by approximately 0.6-0.8  $pK_a$  units. The relatively high heat of ionization (8900 cal/mole) found for groups of  $pK_a$  4.4 and 3.8 seen for sucrose hydrolysis in the free enzyme and enzyme-substrate complex, respectively, may be due to effects of other amino acid side chain residues (possibly tryptophanyl indole; see Leskovac et al. (1975)) at or near the enzyme active center. Tighter binding of sucrose to enzyme, reflected in the ten fold lower Michaelis constant, could change the local protein environment of the active site carboxyl (Koshland, 1970) and effectively alter its heat of ionization. Carboxyl groups have been shown to participate in catalysis of sucrose and isomaltose hydrolysis by sucrose-isomaltase from rabbit small intestine (Brawn et al., 1977) and in sucrose and raffinose hydrolysis catalyzed by *Saccharomyces cerevisiae* invertase (Myrback, 1960; Waheed and Shall, 1971; Shall et al., 1971).

We find little evidence for direct participation of histidyl imidazole in substrate binding or catalysis. This group would have been reflected in an additional bend centered at approximately pH 6-7 in the  $pK_m$  against pH curves (Figure 7). Such curves show the presence of ionizing groups in *both* free enzyme and substrate-complex. Even allowing for decreased enzyme activity at pH's above 6, the graphs at 30° and 50° for sucrose, and at 25° and 50° for raffinose show a smooth transition from lower to higher  $pK_m$  as pH is increased, with no evidence of change near pH 7. These results are different from the results of kinetic studies of *S. cerevisiae* invertase which suggest the participation of an imidazole group at the active center (Myrback, 1960; Dixon

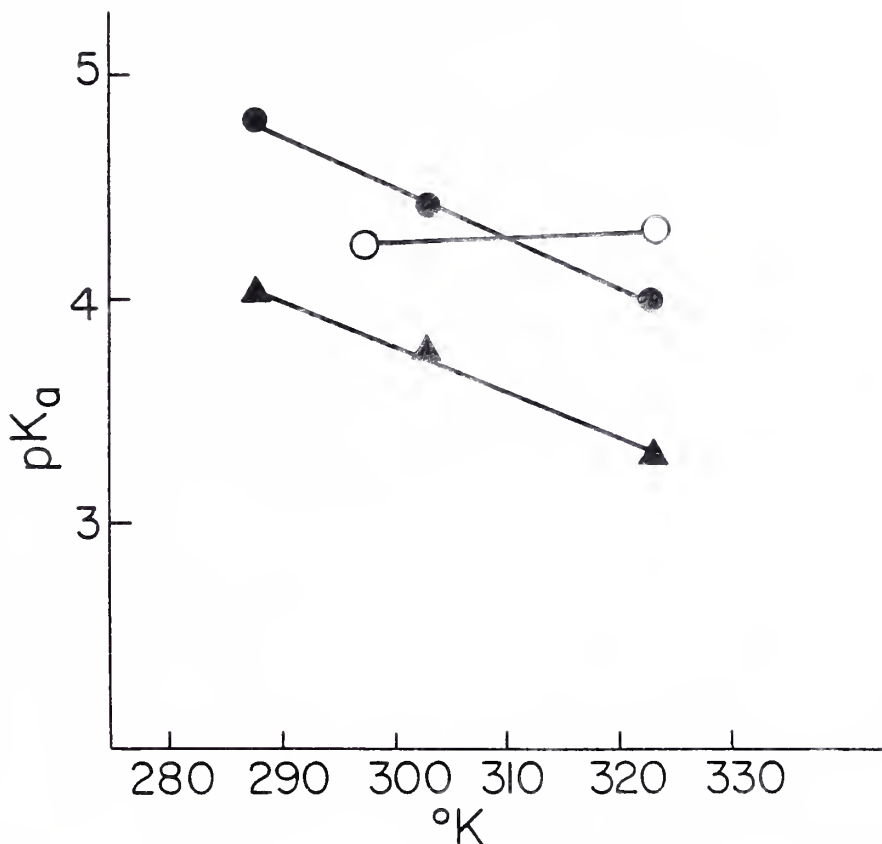


Figure 8. The effect of temperature on the  $pK_a$  of ionizing groups in free enzyme (solid circles) and enzyme-substrate complex (solid triangles) for sucrose hydrolysis, and, in the free enzyme (open circles), for raffinose hydrolysis. The slope of both lines determined for sucrose as substrate is  $-0.022$   $pK_a$  units per degree while the slope of the line for raffinose is  $0.002$  units per degree. Heats of ionization ( $\Delta H_i$ ) were calculated at  $25^\circ$  using the expression  $\Delta H_i = -2.303 R T^2 (dpK_a/dT)$ , where the quantity in parenthesis is the rate of change of  $pK_a$  with temperature (Cohn and Edsall, 1943; Dixon and Webb, 1964).

and Webb, 1964; Fedorov and Malinovskii, 1973). It is possible, although somewhat unlikely, that in *C. utilis* invertase the apparent  $pK_a$  for imidazole is shifted to a higher pH. Log  $V_{max}$  against pH graphs which indicate the presence of ionizing groups in the enzyme-substrate complex are made difficult to interpret in this case by increasing enzyme instability at pH's above 7. In any event, a general mechanism for invertase catalysis may have to do without an imidazole group.

Functional groups ionizing outside the pH range of our study include  $\alpha$ -amino, lysyl  $\epsilon$ -amino, tyrosyl phenolic hydroxyl, cysteinyl sulfhydryl, and arginyl guanidinium. Of these, only the sulfhydryl group has been suggested to participate in catalysis, principally from the results of heavy metal and iodine inhibition studies (Myrback, 1960). However, additional work has shown that some of these results could be explained by postulating a reversible oxidation of the thiomethyl side chain of protein-bound methionine (Shall et al., 1971). Also, invertase from *Neurospora crassa* is not inhibited by iodoacetamide (Bigger and Braymer, 1975), nor is invertase from *S. cerevisiae* inhibited by 5,5-dithiobis(2-nitrobenzoate) (Leskovac et al., 1975), so that a catalytic function for the sulfhydryl group is in doubt. Of the nonionizing side-chain groups, tryptophanyl indole is probably directly involved in catalysis by *S. cerevisiae* invertase (Leskovac et al., 1975) and work should be directed to see whether this group is required in other invertases. Thus, a general mechanism of invertase catalysis might include both protein carboxyl and indole residues.

With sucrose as substrate, our preparation of *Candida utilis* invertase showed significant substrate inhibition, particularly at pH's above 4.5. Substrate inhibition of yeast invertase has also been reported by Dickensheets et al. (1977). The slight sigmoidicity seen in the sucrose concentration-initial velocity curves below pH 4, and the more pronounced sigmoidicity seen in similar curves for raffinose over the entire pH range of our study, is indicative of cooperative substrate binding. However, the physical basis for this action awaits investigation.

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## ABSTRACT

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### KINETIC STUDIES ON RAT LIVER KYNURENINASE

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The pyridoxal-phosphate-requiring enzyme kynureninase participates in liver catabolism of L-tryptophan, mediating the pathway which leads to the synthesis of  $\text{NAD}^+$ . Kynureninase cleaves L-kynurenine or L-3-hydroxykynurenine to give anthranilate or 3-hydroxyanthranilate, respectively. The enzyme was partially purified from rat liver and the Michaelis constants for L-kynurenine and L-3-hydroxykynurenine were determined to be  $2.3 \times 10^{-4} \text{ M}$  and  $6.8 \times 10^{-5} \text{ M}$ , respectively, at pH 8.41 and 37°. With L-kynurenine as substrate, the enzyme was competitively inhibited by several compounds which contained structural features of either amino acid or aryl portions of the substrate. The enzyme was also strongly inhibited by several inhibitors which combined structural features of both amino acid substrate and pyridoxal cofactor. The effect of pH on the initial velocity, maximal velocity, and Michaelis constant, using L-kynurenine as substrate, was studied. The Michaelis constant decreased from  $11.4 \times 10^{-4} \text{ M}$  at pH 7.1 to  $1.3 \times 10^{-4} \text{ M}$  at pH 9.0. Logarithmic plots of these data showed  $\text{pK}_a$ 's for functional groups ionizing in the enzyme-substrate complex and free enzyme active center of 7.6 and 8.5, respectively. The molecular weight of the enzyme was determined by gel filtration to be  $59,000 \pm 5000$ . Paper chromatography of purified enzyme reaction mixtures confirmed the presence of aryl cleavage products of the kynureninase reaction but gave no evidence for L-alanine as the three-carbon product. Current studies in this laboratory appear to indicate that this enzyme is a typical pyridoxal phosphate-requiring eliminase.

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## NOTES

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